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A Contribution to the Study of North American Strigeids (Trematoda)*

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The material upon which this study is based was collected in the states of Ohio, Michigan, and Wisconsin, and consisted entirely of avian parasites. The laboratory work was executed mainly at the Institut de Zoologie of the Université de Neuchâtel (Switzerland). We take this opportunity to thank Dr. Jean G. Baer for making available to us his material and working space.

Fourteen species have been identified, of which 7 are new:

Strigea falconis Szidat
Strigea macroconophora n. sp.
Apharyngostrigea cornu (Zeder)
Apatemon gracilis (Rudolphi)
Cotylurus aquavis (Guberlet)
Cotylurus brevis n. sp.
Cotylurus medius n. sp.
Diplostomum gavium (Guberlet)
Diplostomum repandum n. sp.
Mesoophorodiplostomum pricei (Krull)
Neodiplostomum buteonis n. sp.
Posthodiplostomum minimum (MacCallum)
Uvulifer semicircumcisus n. sp.
Uvulifer magnibursiger n. sp.

Family STRIGEIDAE Railliet

STRIGEA FALCONIS Szidat

This common species was found in 5 specimens of *Buteo jamaicensis borealis* (Gmelin) host numbers 1, 26, 27, 29, 30); the first was collected at Greenville, Ohio, and the other four at Poynette, Wisconsin. This bird is recorded here as a new host.

Strigea macroconophora n. sp.

This strigeid, taken from the small intestine of *Buteo jamaicensis borealis* (Gmelin) (host number 28), collected at Poynette, Wisconsin, September 26, 1946, measures 2.11 to 3.09 mm in total length. The dimensions of the anterior segment are 0.60 to 0.81 mm long, by 0.73 to 1.05 mm wide. The posterior segment, which is subcylindrical and strongly arched, attains a length of 1.41 to 2.34 mm, and width of 0.75 to 0.90 mm which is reduced to 0.52

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to 0.62 mm at the level of the bursa copulatrix. The ratio of the length of the posterior segment to that of the anterior segment, which varies from 2.35 to 2.57 in a state of contraction, reaches 2.92 to 3.08 in normally extended specimens.

The examination of longitudinal sections reveals the existence of strong muscle sheaths; these diverge beginning at the region narrowed by the transverse constriction in order to extend into the posterior segment, in particular, to lose themselves there at different points of the ventral, pretesticular region, or to reach the genital cone following the dorsal surface of the body. The character of this musculature is expressed by the contraction and strong curvature of many specimens.

The terminal oral sucker measures 100 to 153 μ long by 85 to 120 μ wide. It is immediately followed by a spherical pharynx, of which the diameter is 100 to 119 μ. The ventral sucker, situated at the bottom of the cup formed by the anterior segment in the vicinity of the proteolytic gland, measures 190 to 200 μ by 140 to 160 μ.

The posterior segment is characterized by the existence of a well-developed genital cone, and a large bursa copulatrix, of which the pore is terminal; the whole occupies the last third of this part of the body. The ovary, situated between the 21st and the 26th hundredths of the length, recurved in an arch

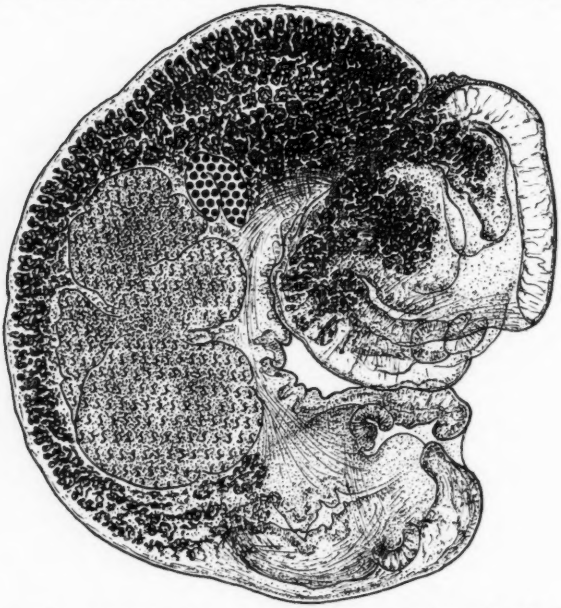

Fig. 1.—*Strigea macroconophora* n. sp., from *Buteo jamaicensis borealis* (Gm.). Type specimen; length: 3.09 mm.

and convex ventrally, measures 130 to 190 μ long along the long axis of the segment, and 250 to 270 μ dorsoventrally. The vitelline glands, amassed mainly in front of the testes, are prolonged under them in order to terminate towards the bursa copulatrix, which is always thus exposed; they penetrate into the anterior segment, constituting an accumulation there, except in the ventral wall, which is totally devoid of them. The eggs measure 90 to 99 μ by 63 to 70 μ.

The massive, coarsely-lobed testes are subequal. The first measures 370 to 600 μ in antero-posterior diameter, and 430 to 600 μ in transverse diameter. The corresponding dimensions of the second are 360 to 510 μ by 440 to 595 μ. The frontal edge of the first is situated between the 25th and the 33rd hundredths of the length of the posterior segment; the posterior border of the second is situated between the 57th and 71st hundredths. The sinuous seminal vesicle approaches tangentially the voluminous genital cone, which is 340 to 660 μ long by 405 to 510 μ wide, and, after an abrupt turn, penetrates it superficially in a dorsoventral direction, following the anterior border of the organ as far as the junction with the uterus, which is introduced a little obliquely at the basal pole, after having curved in to assume the axial direction (fig. 2). The common genital canal empties into a burst copulatrix 260 to 380 μ wide at the level of the muscular ring ("Ringnapf"), and 225 to 405 μ deep.

Fig. 2.—*Strigea macronophora* n. sp., from *Buteo jamaicensis borealis* (Gm.). Sagittal section; length: 2.11 mm.

Strigea macroconophora most nearly approaches the Australian species *S. glandulosa* Dubois (1937a, 1938), from which it is distinguished, nevertheless, by its greater size and by the great development of the genital cone and the bursa copulatrix, which, together, occupy the last third of the posterior segment (instead of the last fourth); by the larger size of the testes; by the shorter extension of the proteolytic gland; and by the geographical distribution.

Host.—*Buteo jamaicensis borealis* (Gmelin).

Locality.—Poynette, Wisconsin.

Habitat.—Small intestine.

Type.—In the collection of the Institut de Zoologie, Université de Neuchâtel.[1]

1 Whenever the quantity of material will permit, specimens will also be deposited in the Helminthological Collection of the U. S. National Museum.

APHARYNGOSTRIGEA CORNU (Zeder)
Syn. *A. bilobata* Olsen, 1940

This worm, studied by I. Ciurea (1927 and 1930); redescribed by one of us (G. D., 1938); then by E. E. Byrd and J. W. Ward (1943); and observed by I. Perez Vigueras (1944) in Cuba, was found in two ardeids, *Ardea h. herodias* L. (host number 3) from Buckeye Lake, Ohio, May 16, 1944, and in *Casmerodius albus egretta* (Gmelin) (host number 1), collected at Bono, Lucas County, Ohio, August 25, 1944.

We consider *Apharyngostrigea bilobata* Olsen, 1940, a synonym of *A. cornu* (Zeder). In fact, the only differential character would be, according to Olsen (p. 324), the bilobed form of the ovary, "being deeply cleft on the posterior margin" (p. 325). Ciurea (1927), not cited in the bibliography, had seen this organ "sensiblement ellipsoïdal, un peu excavé au-dessous," and has figured it as such (pl. I.) We recognized it as "ellipsoïdal ou réniforme" (1938) and represented it as oval (*op. cit.*, fig. 2). In re-examining material collected by Professor Baer (from *Ardea cinerea* L., Geneva, November 2, 1935) and identified as *A. cornu* (Zeder), we have distinguished on many specimens the clearly bilobed contour of the organ, which, in a different perspective, could appear reniform, or even ellipsoidal. Vigueras (1944, fig. 1), in representing *A. cornu*, drew it in reniform; he described it as bilobed in *A. insulae* Vigueras (*op. cit.*, p. 6 and fig. 4). It has resulted, therefore, that the distinctive character of the species described by Olsen is of no value.

Let us note that, in *A. cornu* as in *A. bilobata*, the proteolytic gland, ovoid in contour, is situated at the limit of the two body segments; that it is always exposed by the fact that the vitelline follicles are rather abruptly dispersed at its level, and reappear less numerous anterior to it (they are absent from the ventral wall of the anterior segment, as was remarked by Byrd and Ward, 1943, p. 273); finally, that it is, as Olsen said (p. 323), "strongly lobulated, posterior third composed of a single large piece, anterior two-thirds composed of numerous small lobules, shape longitudinally oval." According to Ciurea (1930, p. 279), the lobules are "plus ou moins triangulaires avec les sommets concentriquees."

APATEMON GRACILIS (Rudolphi)

This cosmopolitan species, common, at any rate, in the northern hemisphere (Europe, Japan, United States, Cuba), redescribed by Stunkard, Willey, and Rabinowitz (1941), was found in the intestine of a specimen of *Mergus serrator* L. (host number 1), collected at Buckeye Lake, Ohio, March 31, 1945. Szidat (1929a, p. 730) already cited this host, which is not mentioned in the *Monagraphie des Strigeida* (1938, cf. note 1, p. 104), because of the uncertainty of the determination.

The utriform anterior segment, more or less elongate and of subquadrangular profile because the dorsal edge is incurved at the level of the ventral sucker, is often withdrawn into the concavity of the second segment (state of contraction). The vitelline follicles nearly reach the posterior extremity of the body, and go up laterally to the front of the bursa copulatrix. The eggs measure 92 to

115 μ by 61 to 80 μ (average: 105 by 71 μ). In specimens fixed normally and not contracted, the testes are cordiform—having two largely rounded lobes, in most cases inequal, and especially so in the second organ—oriented antero-dorsally; the axis of the first is more or less oblique, at times directed nearly crosswise to the body; that of the second is almost longitudinal (fig. 3). The anterior testis measures 270 to 280 μ in dorso-ventral diameter, and 300 to 330 μ in length. The posterior testis, a little more developed, attains a dorso-ventral diameter of 270 to 310 μ; the longitudinal dimensions are 340 to 435 μ, or 300 to 360 μ, according to whether the measurements are of the large or the small lobe.

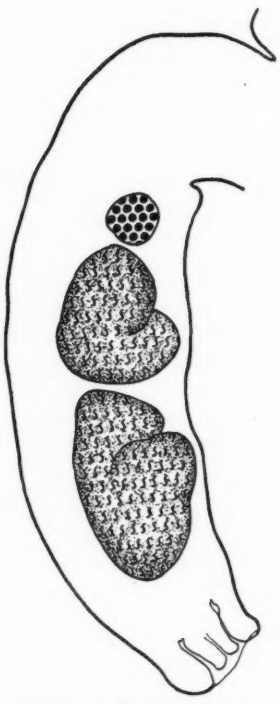

Fig. 3.—*Apatemon gracilis* (Rudolphi), from *Mergus serrator* L. Morphology and topography of the genital glands.

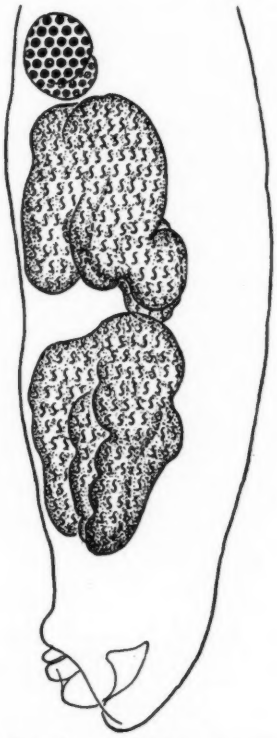

Fig. 4. — *Cotylurus aquavis* Guberlet), from *Gavia immer* (Brünn.). Morphology and topography of the genital glands.

A good representation of this strigeid, in one of its usual positions, is that given by Yamaguti (1933, fig. 2), where one can see the typical general morphology, the form and orientation of the testes, and at the same time the

TABLE I.—A comparison of the measurements of *Cotylurus aquavis* and *Cotylurus erraticus*
(For the genital glands, the dimensions correspond to the antero-posterior diameter/dorso-ventral diameter.)

	C. aquavis		*C. erraticus*	
		Guberlet (1922)	Dubois (1938)	Szidat (1929)
Total length	1900-3130 μ	2500-3500 μ	2000-4200 μ	up to 4000 μ
Length ant. seg.	420-800 μ	500-750 μ	450-1000 μ	900 μ
Length post. seg.	1440-2580 μ	2000-3000 μ	1400-3200 μ	—
Ratio post. seg./ant. seg.	2.8-5.0	—	2.1-5.2	—
Width of ant. seg.	460-780 μ	600-900 μ	540-1130 μ	—
Width of post. seg.	330-540 μ	450-550 μ	360-900 μ	—
Diameter of oral sucker	90-135 μ	110-137 μ	100-215/90-180 μ	150 μ
Diameter of pharynx	65-85/55-82 μ	70-88/55-70 μ	65-155/63-135 μ	70 μ
Diameter of ventral sucker	92-162 μ*	143-192/126-154 μ	150-270/125-235 μ	200 μ
Diameter of ovary	126-190/117-200 μ	177-200/140-250 μ	90-200/125-250 μ	200 μ
Diameter of ant. testis	315-485/230-400 μ	less than second	345-675/305-600 μ**	700 μ
Diameter of post. testis	330-610/225-400 μ	370-440/300-333 μ	390-720/300-660 μ**	
Diameter of eggs	86-103/56-72 μ	86-99/56-71 μ	80-115/50-74 μ	90-110/60-70 μ
Loc. of ovary in post. seg.	40-50/100	—	32-53/100**	—

* With the majority of the specimens, the ventral sucker appears to be a little shriveled, while the oral sucker has a normal appearance.

** Corrected value after having recognized that *C. erraticus* (Rud.), harbored by *Larus canus* L. (Collection of Königsberg, cf. *Monographie des Strigeida*, p. 131), is an aberrant type, in which the testes, insufficiently developed, measure only 200 to 234 μ dorso-ventrally by 145 to 225 μ long for the first, and 215 to 230 μ by 260 to 315 μ for the second. The ovary is situated between the 53rd and the 58th hundredths of the length of the posterior segment (the value 59th hundredth was obtained from an extremely extended specimen, from *Colymbus glacialis* L. = *Colymbus immer* (Brünn.) (André's material).

strong dorsal musculature binding the base of the anterior segment to the region of the first of these organs.

COTYLURUS AQUAVIS (Guberlet)

We found this species in the abundant and complex material from the intestine of *Gavia immer* (Brünn.) (host number 1), collected on November 25, 1946, at Madison, Wisconsin. We indicate here nothing more than the results of our numerous measurements, comparing them with those obtained from a closely related European species, *C. erraticus* (Rudolphi), which is its counterpart.

As may be seen by the comparison of the dimensions given in the preceding table (table I), no quantitative character permits us to oppose these two species. One simply verifies that almost all the measurements made on *C. erracticus* (Rud.) surpass those of *C. aquavis* (Gub.)—except for the ovary. The examples of Rudolphi's species, found in *Larus canus* L. (Königsberg material), appear to us to be distinguished as well from the type form, adapted to *Colymbi*, as the American species. That is why it could be that one would conclude by considering this a variety of *C. erraticus* (Rud.), if not a synonym.

Observations on the morphology of C. aquavis (Gub.).—The testes, anteriorly convex, are divided into three very elongated lobes, directed backward, of which one is sometimes subdivided (giving a count of four), more or less rectilinear or sinuous, and mainly lobed; the second organ is longer than the first, but of the same width (fig. 4). The vitelline follicles extend over the entire ventral face of the second segment, reaching nearly to the posterior extremity and going laterally in front of the ovary, and also behind the testes; they usually taper into the base of the anterior segment.

The muscular process, included within the bursa copulatrix, and known by the name of "genital bulb," is a bulbiform organ only in optical section. In reality, it is a stout, semicircular pad, inserted ventrally in the base of the genital cone—which it encompasses with its free edge, obliquely truncate—protruding with it and protecting it like a viser. We have recognized the same appearance of it in *C. cornutus* (Rud.), *C. erraticus* (Rud.), and *C. platycephalus* (Crep.). It appears indeed to be arranged in this manner in all the species of the genus, as the following show.

Cotylurus brevis n. sp.

This worm was found in the intestine of *Nyroca affinis* (Eyton) (host number 11), from Grosse Ile, Michigan, March 29, 1946.

The total length is between 1.17 and 1.80 mm. The anterior segment, 0.42 to 0.72 mm long and 0.33 to 0.54 mm wide, has the form of a deep cup, more than hemispheroidal, obliquely truncated in front, and from which scarcely emerge the lobes of the tribocytic organ; its ventral border, nearly rectilinear and generally short (0.33 to 0.54 mm), makes a very obtuse angle with the beginning of the posterior segment; on the contrary, its dorsal border, de-

ner (Brünn.) (André's material).

veloped by the very fact of its strong curvature in the form of a sickle, is much longer (0.42 to 0.90 mm) and makes nearly a right angle with the nearly rectilinear profile of the back of the second segment. This, weakly arched and ventrally convex, has the form of a little cucumber, attenuated, and posteriorly truncated. Its dimensions are 0.75 to 1.08 mm in length, by 0.26 to 0.39 mm wide. It is excentrically fixed at the base of the anterior segment, so that the transversal constriction, which separates them, is little marked ventrally. The ratio of the lengths of the two parts of the body (posterior/anterior) varies between the following limits: 1.48 to 1.80. This value, as one can see, is characteristic of the species.

The oral sucker, which occupies the most advanced part of the cup formed by the first segment, measures 81 to 120 μ by 72 to 109 μ, whereas the pharynx, seen with difficulty in total preparations, reaches but 50 to 58 μ by 36 to 45 μ in longitudinal and transverse dimensions. The diameter of the ventral sucker is 110 to 170 μ by 100 to 140 μ.

The ovary, small and ellipsoidal, situated at the beginning of the posterior segment, measures 91 to 96 μ by 70 to 74 μ. The eggs, numbering about 20 in the uterus, are of the same order of size, being 92 to 103 μ long by 63 to 70 μ wide (average 97 by 68 μ). The vitelline glands occupy all the ventral part of the second segment, with the exception of the terminal attenuated zone, in which the bursa copulatrix remains exposed. In the largest of the specimens, a crown of follicles exists in the anterior part of the body, placed ventrally in relation to the acetabulum. This peculiarity constitutes moreover an aberrant disposition.

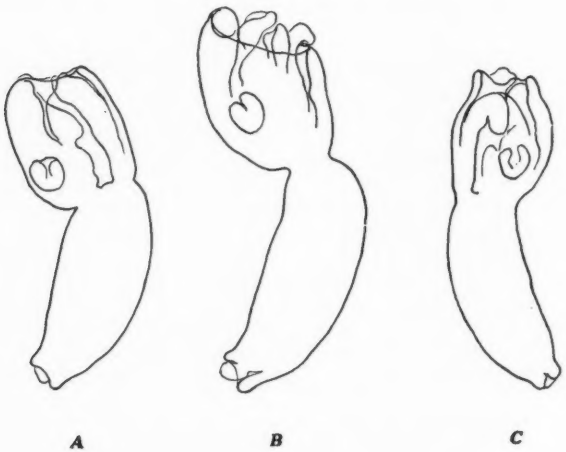

Fig. 5.—Outlines of *Cotylurus brevis* n. sp., from *Nyroca affinis* (Eyton). Length: A) 1.34 mm; B) 1.80 mm; C 1.44 mm.

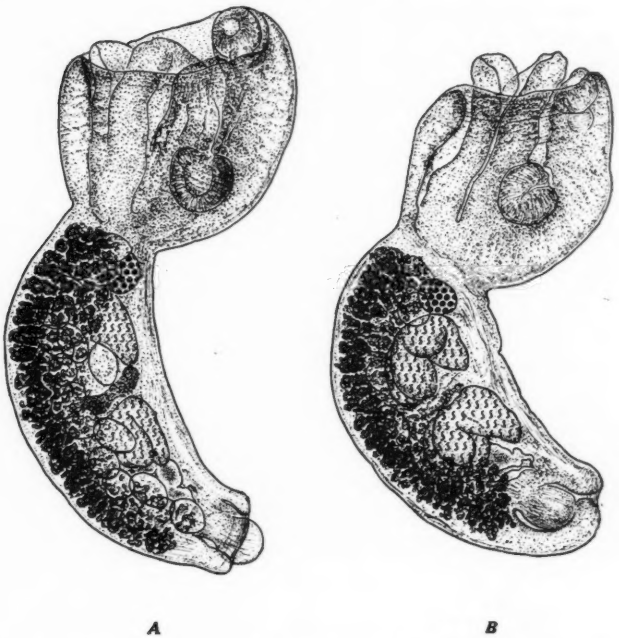

Fig. 6.—*Cotylurus brevis* n. sp. A) from *Nyroca affinis* (Eyton) (Rausch's material). Length: 1.43 mm. B) from *Somateria mollissima* (L.) (Baer's material). Length: 1.49 mm. (Form of the European type).

The testes have their lobes directed posteriorly, and the first measures 190 to 200 μ long, while the second measures 180 to 215 μ.

Some worms, in all points similar to the specimens we are going to describe, and associated with *Apatemon gracilis* (Rud.), constitute material not yet utilized, collected by Professor J. G. Baer at Neuchâtel (Switzerland), in November, 1941, from the intestine of *Somateria mollissima* (L.). The characteristics are: the ratio of the length of the posterior segment to that of the anterior segment has the value included between 1.53 and 1.81; the ovary is situated between the 8th and the 17th hundredths of the length of the posterior segment, and is small, 84 to 115 μ by 75 to 100 μ. The testes are divided into three lobes, largely rounded, and directed backward.

In this regard and for the general morphology, these worms resemble *C. cornutus* (Rud.) enough that we have seen the necessity for examining the diverse materials which served for the description of the latter (cf. *Monographie des Strigeida,* list of hosts, pp. 126-127). A comparative table of the

measurements and their ratios, for each of the lots examined, has convinced us of the existence of two distinct species, easily enough opposable, but nevertheless confused until now. The one is represented by the specimens from *Gallinago gallinago* (L.) Berlin, no. 1378, Rudolphi Collection); from *Vanellus vanellus* (L.) (Upsala); from *Nyroca ferina* (L.) (Bucarest; fig. 64 of the Monograph); and of *Columba livia* Briss. (Sprehn's material). The other is constituted by the examples from *Somateria mollissima* (L.) (Baer's material), which has been mentioned above, to which are added those from the same host collected by Professor André; those from *Nyroca fuligula* (L.) (Fuhrmann's material); and those from *Nyroca marila* (L.) (André's material). The first is indeed the species found by Rudolphi at Greifswald, in the intestine of *Charadrius apricarius* L. = *Charadrius pluvialis* L., and described in 1809. It possesses a "semiglobular" anterior segment, horizontally truncated, and measuring "a peine moins qu'ne ligne" (according to Dujardin: 2.2 mm). The second is *Cotylurus brevis* n. sp., of which the anterior segment, a little longer than wide, is obliquely truncated above the equator of the spheroid to which it can be compared; the total length is less, because the posterior segment is much shorter than it is in Rudolphi's species.

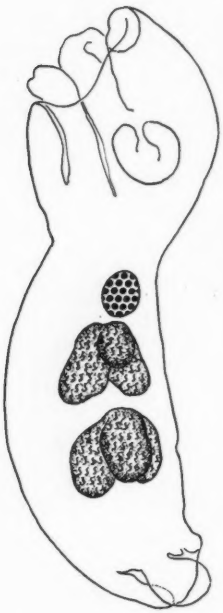

Fig. 7. — *Cotylura brevis* n. sp., from *Somateria mollissima* (L.) (Baer's material). Morphology and topography of the genital glands; length: 1.56 mm.

It is to this second form that can be attributed the worm described by J. Timon-David (1943), under the name of *Cotylurus cornutus* (Rud.), and obtained experimentally from the Chinese teal, *Aix galericulata* L., from the tetracotyles harbored by *Limnaea palustris* (O. F. Müller). The form of the body, the dimensions of the posterior segment (0.76 to 1.0 mm) and of the ovary (95 to 110 μ), and in the same way the value of the ratio "posterior segment to anterior segment" (1.27 to 1.67) permit this attribution.

The following table (table II) introduces the distinctive characters.

The two species which we have just compared are defined as follows: *Cotylurus cornutus* (Rud.) Anterior segment hemispherical, cupuliform, wider than long—from which freely emerge the lobes of the tribocytic organ—delimited by a strong, transverse constriction, and excentrically attached to the posterior segment, which is about 2½ to 4½ times longer, a little arched, and

in the form of an elongate kidney. Vitelline glands strongly developed; follicles strictly limited to the posterior segment, at the beginning of which they have at first a strong density, and occupy the ventral half, up to a little distance from the posterior extremity to the extent that the bursa copulatrix is generally visible. Ovary spherical, of middle size, situated between the 16th and the 34th hundredths of the length of the posterior segment. Testes anteriorly convex, divided into 3 largely rounded lobes, and directed backward.

Hosts.—*Charadrius apricarius* L. (original material); *Gallinago gallinago* (L.) (Rudolphi Collection, no. 1378); *Numenius arquata* (L.) (Skrjabin, 1928[2]; Szidat, 1929a, fig. 26, b); *Scolopax rusticola* L. (probably) (Rudolphi

2 Total length: 1.2 to 3.0 mm.

TABLE II.—Comparison of the dimensions of *Cotylurus cornutus* (Rud.) with those of *Cotylurus brevis* n. sp.

	C. cornutus (Rud.)	*C. brevis* n. sp.	
Geographical distribution	Europe	Europe	North America
Material collected by or at:	Rudolphi, Sprehn (Upsala, Bucarest)	Baer, André Fuhrmann	Rausch
Total length	1250-2200 μ	1000-1770 μ	1170-1800 μ
Length of anterior segment	300-600 μ	390-720 μ	420-720 μ
Length of posterior segment	*900-1820* μ	*650-1110* μ	*750-1080* μ
Ratio of post. segment/ant. segment	*2.43-4.40*	*1.25-1.94*	*1.48-1.80*
Width of anterior segment	340-800 μ	340-690 μ	330-540 μ
Width of posterior segment	380-640 μ	300-660 μ	260-390 μ
Diameter of oral sucker	65-130 μ	85-108/80-108 μ	81-120/72-103 μ
Diameter or pharynx	45-110 μ	indistinct	50-58/36-45 μ
Diameter of ventral sucker	100-200 μ	110-180/96-170 μ	110-170/100-140 μ
Diameter of ovary	*144-216/135-190* μ	*75-150/65-120* μ	*91-96/70-74* μ
Diameter of anterior testis	225-360/210-450 μ	135-295/180-320 μ	190-200/ ? μ
Diameter of posterior testis	270-450/250-450 μ	160-340/180-315 μ	180-215/ ? μ
Diameter of eggs	81-110/51-73 μ	91-110/50-70 μ	92-103/63-70 μ
Position of ovary in post. segment	*16-34/100*	*8-17/100*	*11-22/100*
	av. 24/100	*av. 13/100*	—

(For the testes, the dimensions correspond to the antero-posterior diamet er/dorso-ventral diameter.)

Collection, no. 1385); *Vanellus vanellus* (L.) (Upsala material)[3] *Nyroca ferina* (L.) (Bucarest material); *Columba livia* Briss. (Sprehn's material, Bittner, 1927).

Habitat.—Intestine.

Distribution.—Europe and Transbaikal.

Cotylurus brevis n. sp.—Anterior segment subglobular, generally longer than wide, in the form of a deep, spheroidal dome, obliquely truncated in front and narrowed at the mouth—from which hardly emerge the lobes of the tribocytic organ—curved at the dorsal border as a sickle, and at the extremity of which the oral sucker juts out; posterior segment 1¼ to 2 times longer, a little arched in the form of a kidney or a little cucumber, delimited by a transversal constriction—not distinct ventrally—and attached excentrically to the preceding. Vitelline glands much developed; follicles limited to the posterior segment, at the beginning of which they have at first a greater density, and of which they occupy the ventral half to within a short distance of the posterior extremity, so that the bursa copulatrix is generally visible. Ovary of small size, ellipsoidal, situated between the 8th and the 22nd hundredths of the length of the posterior segment. Testes anteriorly convex, divided into three lobes, largely rounded and directed backwards (fig. 7).

Hosts.—*Somateria mollissima* (L.) (Baer's and André's material); *Nyroca fuligula* (L.) (Fuhrmann's material); *Nyroca marila* (L.) André's material); *Nyroca affinis* (Eyton) (Rausch's material); *Aix galericulata* L. (Timon-David, 1943).

Habitat.—Intestine.

Distribution.—Europe and North America.

Types and cotypes.—from *Somateria mollissima* (L.) (Baer's material, of November, 1941), deposited in the collection of the Institut de Zoologie, Université de Neuchâtel.

Remark I. It is confirmed that two species have been confused up to now under the name of "*Cotylurus cornutus* (Rud.)." One could expect such a duplication for several reasons: (1) variable position of the ovary; form of the globular to hemispherical anterior segment, which is now wider than long, now longer than wide; distant limits of the value of the ratio "posterior segment to anterior segment"; (2) differences observed between the two related cercariae: *Cercaria A.* Szidat,[4] considered to be the larva of *Cotylurus cornutus* (Rud.), and *Cercaria helvetica* XXXIV Dubois, 1934; (3) facultative

3 Nazmi (1935) cited *Oedicnemus crepitans* Temm. as host of *Cotylurus cornutus*, but, in absence of data on the parasite, one can not be sure that it is Rudolphi's species.

4 Probably identical with *Cercaria sanjuanensis* Miller, 1927.

or conditional evolution of the metacercariae either in the hermaphrodite gland of molluscs, or in the circulatory system of leeches; (4) more or less free adaptation of the adults to two orders of birds: the *Charadrii* and the *Anseres*.[5]

Remark II. The two species of *Cotylurus* for which we have just established the diagnoses have not only been taken one for the other, but have been often confused with *Apatemon gracilis* (Rud.), which is of about the same size, and which also belongs to the sub-subfamily *Cotylurini* Dubois. Certainly, aside from their different morphology and the difference in the copulatory apparatus (cf. Szidat, 1929b, p. 145, fig. 5 and 6), they are anatomically distinguished by their male sex glands: in *A. gracilis*, the cordiform testes orient their two lobes antero-dorsally, whereas in *C. cornutus* and *C. brevis*—as in other respects with *C. aquavis* (Guberlet) and its counterpart, *C. erraticus* (Rudolphi) (Europe)—the two organs, anteriorly convex, are divided into three lobes directed backward.

Remark III. *Cotylurus flabelliformis* (Faust) is distinguished from the two species which we have just compared by the much smaller size (0.56 to 0.85 mm) and by the fact that the oral sucker is nearly equal to the acetabulum.

Cotylurus medius n. sp.

The description of this species is based on the examination of two lots of material from the small intestine of *Sterna hirundo* L. (host numbers 1 and 2), collected on August 25, 1944, at Bono, Ohio.

The birds from which these trematodes were taken were still in the down stage, and were taken directly from the nest. It is of interest to note that we have not taken this strigeid from adult terns, of which 23 have been examined. All the birds examined were taken from the same general region (central part of Lake Erie, in both Ohio and Michigan).

The total length of this worm varies between 2.10 and 3.75 mm. From point of view of size, this form is intermediate between the smallest, as *C. flabelliformis* (Faust), and the largest, such as *C. communis* (Hughes). According to its dimensions and occurrence, it appears to be very similar to *C. pileatus* (Rud.), found in Europe in gulls and terns.

The anterior segment, largely cupuliform, depressed, and compact, more rarely sub-globular, measures 0.50 to 0.84 mm in length, by 1.0 to 1.41 mm transversely. It is excentrically fastened to the thick posterior segment, more

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5 Mathias (1925, p. 32) reported having readily obtained the one of these parasites by experimental infection of tame and wild ducks, but to have tried vainly to obtain it in the lapwing (nutritional conditions ?).

or less arched, sub-reniform to sacciform—rounded or truncated at the extremity—distinctly separated from the preceding by a strong, transverse constriction; the dimensions are 1.60 to 3.0 mm in length, by 0.84 to 1.44 mm in width. The ratio of the lengths of the second segment to the first is 2.80 to 4.10.

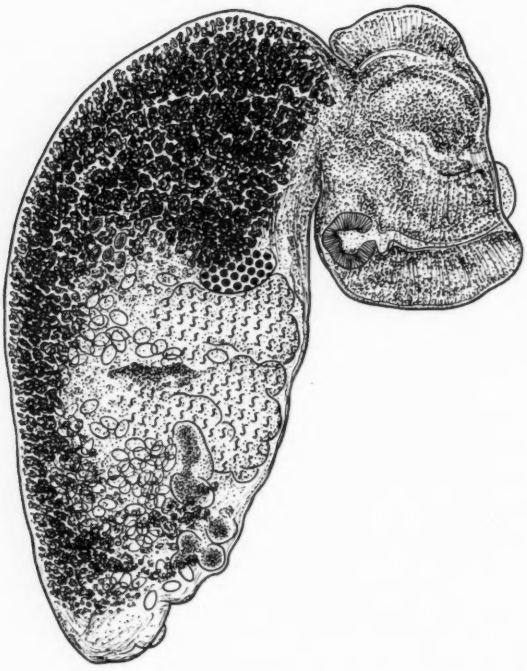

Fig. 8.—*Cotylurus medius* n. sp., from *Sterna hirundo* L. Type specimen; length: 3.75 mm.

The diameter of the submarginal oral sucker—of which the center is situated between the 16th and 19th hundredths of the length of the anterior segment, and of which the frontal border is 20 to 55 μ distant from the margin of this—is from 140 to 163 μ; the dimensions of the ventral sucker reach 180 to 270 μ; those of the pharynx from 90 to 155 μ by 80 to 125 μ.

The ovary, which one sees between the 36th and 50th hundredths of the posterior segment, measures 180 by 250 μ in diameter. It is placed dorsally, immediately in front of the massive testes, which are roughly multilobed, and of which the dimensions (longitudinal/dorso-ventral) reach, for the first, 540 by 720 μ, and for the second, 780 by 690 μ. The uterus develops numerous

convolutions filled with eggs over all the length of the segment; the eggs measure 96 to 126 μ by 53 to 78 μ (average 105 by 63 μ). The vitelline follicles are concentrated anteriorly, ventrally, and posteriorly in relation to the genital glands, and extend almost to the extremity of the body, completely masking the bursa copulatrix, of which the pore is dorsal and subterminal, only if it is retracted.

Cotylurus medius is, in North America, the counterpart of *C. pileatus* (Rud.), of Eurasia. It is perhaps distinguished adequately by the distinctly greater dimensions of the eggs (those of *C. pileatus* measured by one of us (G. D.): 82 to 99 μ by 50 to 66 μ; according to Szidat: 90 by 50 μ); by the widening of the anterior segment (which has a diameter of but 0.81 to 1.02 mm in the Eurasiatic species); and by the greater development of the pharynx (80 to 100 μ in *C. pileatus*), when the oral suckers of the two species are subequal.

Host.—*Sterna hirundo* L.

Habitat.—Intestine.

Distribution.—Bono, Lucas County, Ohio.

Types and Cotypes.—deposited in the collection of the Institut de Zoologie, Université de Neuchâtel.

Family DIPLOSTOMATIDAE Poirier

DIPLOSTOMUM GAVIUM (Guberlet)

A dozen specimens of this diplostome were found in the material from *Gavia immer* (Brünn.) (host number 1); these serve us as a basis for the redescription of *C. aquavis* (Gub.). Here are the results of our measurements:

Total length	1050 to 1740 μ
Length of anterior segment	690 to 1140 μ
Length of posterior segment	330 to 660 μ
Width of anterior segment	325 to 480 μ
Width of posterior segment	250 to 350 μ
Width at level of bursa copulatrix	185 to 230 μ
Ratio of lengths of posterior segment to anterior segment	0.45 to 0.65

Diameters of:	antero-posterior	transverse
oral sucker	72 to 98 μ	80 to 108 μ
pharynx	60 to 72 μ	48 to 57 μ
ventral sucker	70 to 100 μ	80 to 115 μ
tribocytic organ (expanded)	180 to 315 μ	210 to 395 μ
ovary	110 to 115 μ	117 μ
first testis	100 to 200 μ	260 to 330 μ
second testis	120 to 195 μ	240 to 280 μ
eggs	85 to 92 μ	54 to 66 μ
Length of pseudo-suckers		180 to 280 μ
Distance from posterior edge of ventral sucker to anterior edge of tribocytic organ (in expansion)		30 to 70 μ

Diameter of genital cone	85 to 135 μ
Antero-posterior diameter of genital pore	90 to 225 μ
Position in the anterior segment of:	
posterior edge of pseudo-suckers	20–26/100
anterior limit of vitelline follicles	31–40/100
ventral sucker	51–60/100
anterior margin of tribocytic organ	60–69/100
center or tribocytic organ	73–83/100

Observations on the morphology of D. gavium (*Gub.*).—The bisegmentation of the body is slightly demarcated. The limit of the two parts is seen, in specimens viewed from the side, as a rather abrupt flexion, visible chiefly on the ventral profile, where it makes an obtuse angle. The anterior segment is characterized by the existence of very large pseudo-suckers. The extremity of the conical posterior segment is dorsally more or less distinctly bent in the attenuated region which contains the bursa copulatrix, and which is delimited by a very slight constriction.

In the specimens of this lot, the oral sucker is sometimes a little larger than the ventral sucker, sometimes it is the opposite; one can say that the two organs are subequal in diameter (Guberlet, 1922, p. 9, indicated 60 by 80 μ for the first, and 70 μ for the second). The tribocytic organ, everywhere expanded, is wider than long (the dimensions given by Guberlet correspond to a state of contraction: 135 to 175 μ in length, by 100 μ in width, cf. pl. V, fig. 11).

In the anterior segment the vitelline follicles extend nearly to the middistance between the two suckers; they are rather abundant at the level of the tribocytic organ, which they overgrow. In the posterior segment their field is restricted to the level of the first testis, to constitute a narrow median and ventral strip, which terminates as two small, lateral curls, behind the second testis; that is to say, anterior to the bursa copulatrix. This always remains exposed, therefore; it screens a genital cone and opens by a large, subterminal, dorsal pore.

In the specimens seen face-on, and on account of the flexion of the long axis of the body, the laterally situated ovary projects into the basal region of the anterior segment, encroaching sometimes into the zone of the tribocytic organ. The testes, bilobed or in the form of a dumb-bell, occupy all the width of the first half of the posterior segment: the first of these organs is more developed, in the transverse direction, than the second.

Diplostomum repandum n. sp.

These trematodes were taken from the intestine of *Sterna hirundo* (L.) (host number 1), collected August 25, 1944, at Bono, Ohio. They are characterized by their strong flexure as much as by the great development of the tribocytic organ.

The total length of the body—which is divided by a strong transverse constriction—varies from 1.20 to 2.34 mm. The anterior foliform segment, of

oval contour, is depressed in the contracted state, taking the appearance of a cup of which the turned up borders screen a fungoid tribocytic organ. Its dimensions are 0.51 to 1.02 mm in length, by 0.72 mm in maximum width (measured in the second half in two *en face* specimens). The posterior segment, ovoid to sacciform, is sub-equal to the preceding, to the dorsal surface of which it is attached, and becomes attenuated, making with it nearly a right angle—which explains that the greater part of the specimens, mounted as total

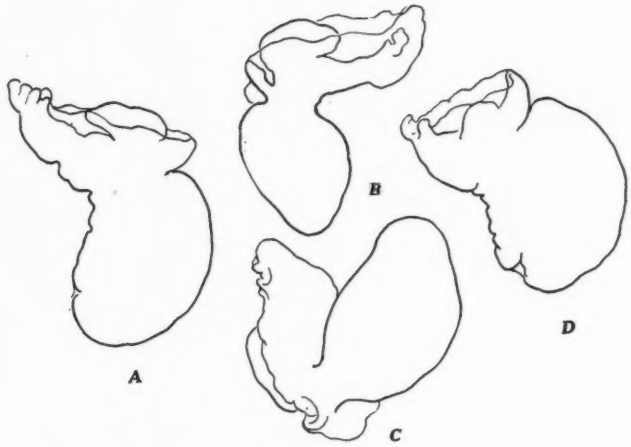

Fig. 9.—Outlines of *Diplostomum repandum* n. sp., from *Sterna hirundo* L. Length A) 1.38 mm; B) 1.29 mm; C) 1.70 mm; D) 1.20 mm (strongly contracted).

preparations, are placed on the side and appear strongly bent. Its length varies from 0.58 to 1.38 mm; its width from 0.57 to 0.63 mm; and its dorso-ventral diameter from 0.42 to 0.63 mm. The ratio of the length of the posterior segment to that of the anterior segment has a value between 0.76 and 1.57, with an average of 1.12.

The oral sucker, globular in shape, measures 86 to 115 μ in antero-posterior diameter, by 86 to 120 μ in transverse diameter. It is flanked by two semi-lunar pseudo-suckers, situated at the level of the pharynx. This is strongly muscular, largely ellipsoidal, and nearly spherical when it is contracted; its length is from 79 to 96 μ, and its transverse diameter from 65 to 95 μ. The bifurcated intestine has no oesophagus. A single specimen presented a face-on view of the ventral sucker; this measured 115 by 137 μ. On the other examples the acetabulum, which is situated between the 44th and 50th hundredths of the length of the anterior segment, is covered in part or totally by the tribocytic organ; this, in a state of expansion on all specimens, measures 320 to 480 μ in length by 460 to 490 μ in width; its anterior border and its center are found respectively between the 35th to 50th hundredths and the

60th to 70th hundredths of the length of the first segment. This last dimension, in relation to the longitudinal diameter of the tribocytic organ, gives a value between 1.56 and 2.60 (average: 2.09). The sections reveal the great development of the proteolytic gland.

The testes distend the posterior segment. The second, larger than the first, occupies all the width and measures 500 to 520 μ in the transverse dimension, and 225 to 330 μ longitudinally on one or the other of its sub-equal halves. Its posterior margin is situated between the 70th and the 79th hundredths of the length of the segment. The first testis, asymmetrical, or, in all cases, more developed on the side where the larger half of the second is found, attains 160 to 250 μ in the antero-posterior dimensions.

The ellipsoidal ovary, placed between the 18th and 26th hundredths of the length of the segment, measures 117 to 135μ by 145 to 160 μ. The vitelline follicles accumulate in the restricted space which occurs in front of the genital glands, becoming reduced to a ventral, median ribbon, allowing the exposure 320 to 480 μ in length by 460 to 490 μ in width; its anterior border and its center are found respectively between the 35th to 50th hundredths and the 60th to 70th hundredths of the length of the first segment. This last dimension, in relation to the longitudinal diameter of the tribocytic organ, gives a value of the lateral parts of the testes, and abutting against the two rather compact, terminal accumulations behind these. In the anterior segment, one finds them widely distributed, invading the tribocytic organ and having their limit between the 30th and 41st hundredth of this part of the body. The numerous eggs measure 90 to 108 μ by 60 to 72 μ.

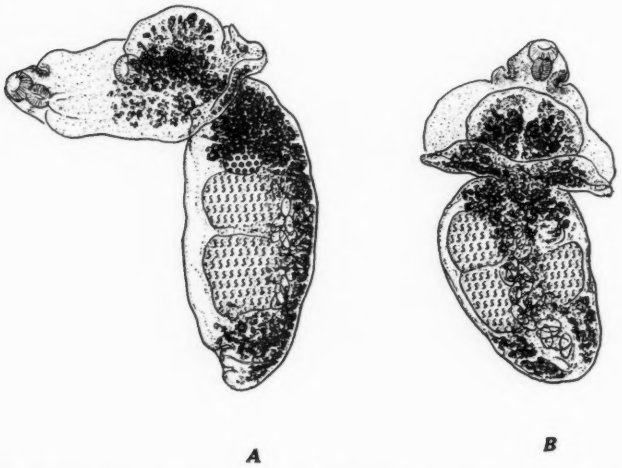

Fig. 10.—*Diplostomum repandum* n. sp., from *Sterna hirundo* L. A) Lateral view; length: 1.89 mm. B) Ventral view; length: 1.47 mm.

The bursa copulatrix, of which the pore is dorsal and subterminal, is not deep. The common genital canal, which prolongs the incurved uterus, empties here, sometimes carried outward by an eminence more or less distinct, and resembling a genital cone.

This species, characterized as we have indicated above, is distinctly differentiated from those found in North American larids: *D. flexicaudum* (Cort and Brooks), *D. indistinctum* (Guberlet), and *D. huronense* (La Rue). It is not to be confused with the diplostomes of the stercorariids (*D. baeri* Dubois, 1937a and 1938), found in Switzerland, nor with *D. commutatum* (Diesing) of Europe, a parasite of terns, with which it has the most analogy. The last, however, surpasses it (2.40 to 3.18 mm), having a long ovoid, or fusiform to claviform, posterior segment, which at the same time is much wider (ratio of lengths of "posterior segment to anterior segment" = 1.58 to 1.97); the longitudinal axis of its pharynx (84 to 91 μ) exceeds that of the oral sucker (75 to 82 μ); the genital glands are much larger; and the body does not show the flexure characteristic of *D. repandum*.

The description of *Diplostomum micradenum* (Cort and Brackett), given by Olivier (1940), and figures 11 to 13 which illustrate it, do not reveal adequately the features of the species to permit a rigorous comparative examination. That is why we place in *addendum* a figure of this species, executed after one of the specimens of the original material (U. S. N. M., Helm. Coll., no. 36701). *D. micradenum* is of much smaller size (1.04 to 1.35 mm) than *D. repandum;* the division of its unbent body into two segments is marked only by a very weak transverse constriction. The length of the first asymmetrically developed testis (150 to 220 μ) surpasses that of the second (130 to 190 μ).

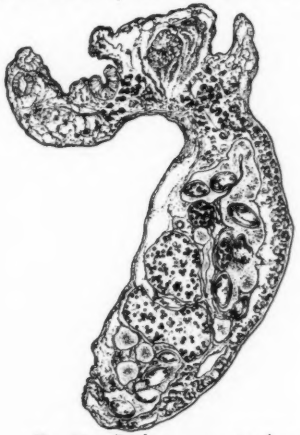

Fig. 11.—*Diplostomum repandum* n. sp., from *Sterna hirundo* L. Sagittal section.

Host.—(of *D. repandum* n. sp.) *Sterna hirundo* (L.).

Habitat.—Intestine.

Distribution.—Bono, Lucas County, Ohio.

Type.—Deposited in the collection of the Institut de Zoologie, Université de Neuchâtel.

MESOOPHORODIPLOSTOMUM PRICEI (Krull)

Many specimens of this species belonging to a genus well characterized by the intertesticular ovary and the evaginable bursa copulatrix, were found among

specimens of diplostomes from gulls,[6] collected from the intestine of *Larus argentatus* Pont. (host number 13), captured at Madison, Wisconsin, November 13, 1946.

Some have no eggs, while others contain eggs (1 to 5). Being fixed in a state of extension, and measuring 1.90 to 2.28 mm in total length, by 0.37 in maximum width, they appear not to have attained their full deveolpment. Their slenderness contrasts with the more massive form of the original specimens, experimentally obtained by Krull in *Larus novae-hollandiae* Stephens. Nevertheless, it is of the same species, as the following measurements and their ratios show (cf. *Monographie des Strigeida*, pp. 209-210, and fig. 131):

6 These will be ultimately determined.

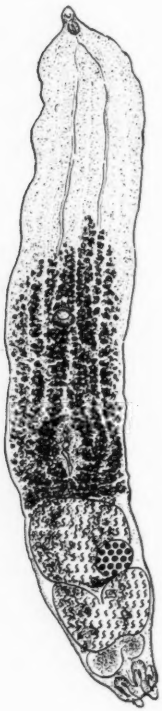

Fig. 12.—*Mesoophorodiplostomum pricei* (Krull), from *Larus argentatus* Pont. Length: 2.07 mm.

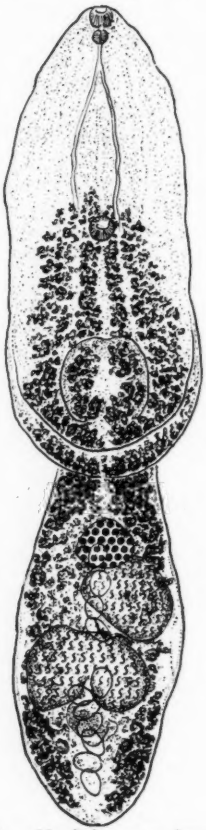

Fig. 13.—*Neodiplostomum buteonis* n. sp., from *Buteo jamaicensis borealis* (Gm.). Type specimen; length: 2.95 mm.

Anterior segment	1.23 to 1.44 mm by 0.36 to 0.37 mm.
Posterior segment	0.63 to 0.75 mm by 0.30 to 0.33 mm.
Ratio of the length of the posterior segment to that of the anterior segment	0.43 to 0.56.
Diameters of:	
oral sucker	50 by 40 μ.
pharynx	35 to 29 μ.
ventral sucker	60 to 63 by 72 to 81 μ.
tribocytic organ	205 to 250 by 200 to 210 μ.
ovary	90 to 100 by 97 to 117 μ.
first testis (longitud./transverse)	220 to 270 by 250 to 290 μ.
second testis (longitud./transverse)	180 to 230 by 280 to 295 μ.
eggs	86 to 89 by 59 to 61 μ.
Location in the anterior segment of:	
most advanced vitelline follicles	36 to 42/100.
ventral sucker	59 to 64/100.
anterior border of tribocytic organ	80 to 83/100.
Location in the posterior segment of:	
anterior margin of first testis	0/100.
posterior margin of second testis	65 to 74/100.

Besides the situation of the ovary between the testes and the extrusability of the bursa copulatrix, the characters of the species are:

(1) slightly demarcated bisegmentation of the body;

(2) the slight excavation of the foliform anterior segment, which is pointed at the cephalic extremity, occupied by a small oral sucker;

(3) the ovoid to subconical form of the posterior segment, which is shorter than the preceding;

(4) the extension of the testes over all the width of the first 2/3 to the first 4/5 of the segment—the first, of which the frontal edge is exactly at the limit of the two parts of the body, being ellipsoidal and transversely elongated; the second, reniform to sub-cordiform, with an anterior concavity and curved in a horse-shoe shape, is larger than the preceding;

(5) the limits of the vitelline follicles are in front of the ventral sucker, and at the level of the posterior border of the second testis.

Neodiplostomum buteonis n. sp.

This worm, found with *Strigea falconis* Szidat, was collected from the intestine of *Buteo jamaicensis borealis* (Gmelin) (host number 1), shot on October 29, 1944, at Greenville, Ohio.

The body, distinctly bisegmented, measures from 2.64 to 2.95 mm in total length. The elongate elliptical to lanceolate anterior segment has borders curved only backward, where it is wider; its dimensions are: 1.47 to 1.66 mm by 0.66 to 0.69 mm. The posterior segment, in form of an elongate ellipsoid, is always shorter than the preceding. The measurements of the main axis vary between 1.17 and 1.30 mm; its transverse diameter reaches the maximum

at the level of the testes, being 0.60 mm. The ratio of the length of the posterior segment to that of the anterior segment is between 0.74 and 0.81.

The oral sucker measures 62 to 72 μ long by 67 to 81 μ wide. The ventral sucker, larger and circular, has a diameter of 80 to 85 μ; it is situated on an average at 47 hundredths of the length of the anterior segment. Its posterior border is at a distance of 225 to 315 μ from the anterior edge of the tribocytic organ. This, approximately circular, measures 315 to 335 μ in length, and 290 to 315 μ in width. Thus its diameter is equal to the distance which separates it from the ventral sucker. Its front is situated between the 65th and the 71st hundredths of the length of the anterior segment; its center between the 75th and the 80th hundredths. The ratio of the length of the anterior segment to that of the tribocytic organ varies from 4.66 to 5.24.

Preceded by a short prepharynx (0 to 12 μ), the spherical pharynx measures 54 to 60 μ in length, by 55 to 62 μ in width. The oesophagus reaches a length of 60 to 90 μ. The ceca are narrow (about 10 to 15 μ) in their visible section.

The ovary, situated between the 16th and 21st hundredths of the length of the posterior segment (average of 1/5), measures 160 to 165 μ in longitudinal diameter, and 190 to 210 μ in transverse diameter. In the anterior segment, the vitelline glands have their limit at the level of the front of the ventral sucker, or slightly ahead of it (that is, between the 40th and the 44th hundredths of the length of the segment). From thence, and toward the rear, the follicles, separated in longitudinal bands, widen their rows a little to reach the margins of this part of the body, and show its narrow fold by their greater density. In the posterior segment, they are prolonged in the form of two lateral clusters, interrupted in the zone of the testes, and reappearing wider, but a little less dense, beyond these organs, to terminate in the rounded extremity of the segment. The eggs, few in number, measure 92 to 101 μ by 59 to 75 μ (average: 97.5 by 69.5 μ). The genital pore is dorsal and subterminal; the anterior border of the bursa copulatrix is found between the 82nd and the 85th hundredths of the length of the posterior segment. The common genital canal does not traverse a genital cone.

The first testis is asymmetrically developed, largely ovoid to claviform, and placed laterally behind the ovary; it measures 270 to 305 μ in the longitudinal dimension, and 305 to 315 μ transversely. The second testis is clearly bilobed (with a posterior median indentation), and reaches 420 to 440 μ in transverse diameter; that of the two lobes which occupies the field of the first testis is smaller, measuring but 225 to 250 μ long; the other reaches 270 to 305 μ in length. The anterior border of the first testis is situated between the 21st and the 25th hundredths of the length of the segment; the posterior border of the second between the 66th and the 69th hundredths.

Host.—*Buteo jamaicensis borealis* (Gmelin).

Habitat.—Small intestine.

Distribution.—Greenville, Ohio.

Type.—Deposited in the collection of the Institut de Zoologie, Université de Neuchâtel.

The new species is related to 7 other neodiplostomes described as parasites of different buteonine birds, and of which one of the common and significant characters is furnished by the first, asymmetrically developed, claviform testis, which is situated more or less laterally. If one should judge them by the brief original description of von Linstow (1906), it nearly resembles *N. attenuatum*, which is distinguished from it by the limit of the vitelline glands (33/100 to the length of the anteror segment), situated well in advance of the ventral sucker (53/100).

With *N. krausei* Dubois, 1937, this limit coincides indeed with the frontal border of the acetabulum, but the worm is two times smaller; the ventral sucker is found between the 54th and 62nd hundredths of the length of the anterior segment, which reduces to 60 μ, at the most, the distance from its posterior border to the front of the tribocytic organ. In *N. pseudattenuatum* (Dubois, 1928), the cylindrical posterior segment is subequal to the anterior segment, of which the second half, or even the last 3/5 are in the main occupied by the tribocytic organ; the vitelline follicles extend beyond the ventral sucker (situated between the 40th and the 46th hundredths of the length of the segment). It is the same, in regard to the extension of the vitelline glands in *N. inaquipartitum* Dubois, 1935, but the acetabulum is placed at the center of the anterior segment which is 1 3/5 to 2 times longer than the ovoid posterior segment, and of which the last 2/5 constitute the zone of the tribocytic organ. These four species are European.

With *N. rufeni* Chatterji, 1942, found in India, the posterior segment is longer than the anterior, and the suckers are subequal between them.[7] *N. biovatum* Dubois, 1937, which is Brasilian, is distinguished from its congeners by the feeble transverse constriction of its body, and by the fact that the oral sucker is the same size, or often slightly larger than the ventral sucker, which is surpassed by the vitelline follicles. Among North American forms parasitic in diurnal raptors, only *N. paraspathula* Noble, 1936, is known at present, of which the total length and the proportion of the segments of the body correspond well enough to those of the new species, but the advance of the vitelline glands suffices to distinguish it.

POSTHODIPLOSTOMUM MINIMUM (MacCallum)

Some examples of this species, to which M. S. Ferguson has devoted much study, were found associated with *Apharyngostrigea cornu* (Zeder), mentioned above, and collected from a specimen of *Ardea herodias* L. (host number 3), captured at Buckeye Lake, Ohio, May 16, 1944. One among them, because of its size, surpasses anything that has been observed up to now: total length 1.59 mm; length of posterior segment 0.54 mm; of the anterior segment

[7] *Neodiplostomum rufeni* has to be placed in the subgenus *Neodiplostomum*, and not in *Conidioplostomum*, as Chatterji (1942, p. 25) claimed. The error in attribution arose in that the author considered as "genital cone" (fig. 2) a portion of the thick posterior wall of the bursa copulatrix, isolated in appearance (in the sagittal section) by the opening effected by the common genital canal in arriving in the "genital atrium."

1.05 mm; ratio of these last two dimensions = 0.51. Width of the anterior segment in its first half is 0.57 mm, and at the level of the tribocytic organ 0.47 mm; width of the posterior segment 0.42 mm. Diameter of the oral sucker 45 by 52 μ; of the pharynx 29 by 31 μ; of the ventral sucker 81 by 89 μ; and of the tribocytic organ 190 by 145 μ.

The anterior limit of the vitelline follicles is found between the 51st and the 54th hundredths of the length of the first segment, whereas the ventral sucker is situated there between the 64th and the 66th hundredths. Thus, the follicles pass by 100 μ the level of the frontal border of the last; as with *P. cuticola* (von Nordmann), of Europe, and with *P. australe* Dubois, of Australia, they are restricted in a field having almost the same width as the second cvoid segment, in which they are extended ventrally up to the height of the posterior border of the second testis.

Uvulifer semicircumcisus n. sp.

Many examples of this worm were collected from the intestine of a specimen of *Megaceryle alcyon* (L.) (host number 4), shot on August 10, 1946, at Pte. Mouillee, Michigan.

The total length of the body is from 1.66 to 1.86 mm. The oval anterior segment, cochleariform and projecting ventrally at the posterior border, measures 0.39 to 0.52 mm long, by 0.27 to 0.32 mm wide, and 0.13 to 0.20 mm in maximum height posteriorly. The tribocytic organ, of which the antero-posterior diameter reaches 0.12 to 0.17 mm, shows up in its concavity. The posterior segment, inserted at the dorsal face of the preceding, is cylindrical or claviform, and arched chiefly at the neck, which is more narrow. This explains why all the specimens were mounted on the side. The posterior segment measures 1.26 to 1.62 mm long, and 0.27 to 0.40 mm in dorso-ventral diameter, of which the maximum is at the height of the testes. Its posterior extremity, less wide and rounded, appears obliquely truncate by examination of the profile, by the fact that the terminal genital pore is oriented dorsally. The ratio of the length of the posterior segment to that of the anterior segment is 2.54 to 3.25.

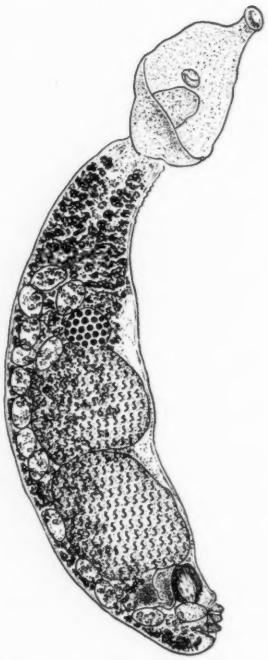

Fig. 14. — *Uvulifer semicircumcisus* n. sp., from *Megaceryle alcyon* (L.). Length: 1.78 mm.

At the attenuated extremity of the anterior segment, the oral sucker pro-

trudes, measuring 48 to 65 μ in length, and 60 to 80 μ transversely. The mediocre state of preservation of this part of the body did not permit us to indicate the dimensions of the pharynx, seen only in a single individual. The ventral sucker, situated immediately in front of the tribocytic organ, being a little near to the middle of the length of the anterior segment, is but 40 to 49 μ in diameter.

The spherical ovary is found between the 32nd and the 42nd hundredths of the length of the second segment (average 35/100). Its diameter is from 108 to 120 μ. The vitelline glands occupy all the posterior segment, extending from one extremity to the other, without interruption. They reveal only the two testes laterally, and mask the bursa copulatrix. The vitelline reservoir is intertesticular. The eggs, numbering from 1 to 20 in the uterus, measure 80 to 102 μ by 53 to 67 μ (average: 92 by 60 μ).

With the bursa copulatrix the massive, unlobed, ovoid or ellipsoid testes occupy the last 3/5 of the posterior segment; the second is always longer than the first, and compresses the seminal vesicle between the terminal part of the uterus and the ejaculatory pouch. The dimensions of the anterior testis are: 260 to 350 μ in length by 180 to 300 μ dorsoventrally (average: 285 by 245 μ); those of the posterior testis: 290 to 400 μ by 200 to 295 μ (average: 359 by 242 μ). The ejaculatory pouch is situated dorsally; it measures 90 to 120 μ long by 63 to 85 μ wide; its walls, 8 to 25 μ thick, appear strongly muscled. It empties directly into the uterus, which approaches it near the outflow channel, curving dorsally to become, at the point of confluence, the short common genital canal, which traverses the genital cone. The latter is sheltered in the bursa copulatrix, 72 to 100 μ deep. This thick-set cone, 45 to 60 μ high, is directed parallel to the longitudinal axis of the body, in the prolongation of the excretory pouch itself. It is enveloped ventrally by an exsertable coil, in the form of a rounded and concave small strip, 60 to 70 μ long, and 15 to 22 μ thick, which is rooted at its base. This coil is applied on its side and scarcely projects over its top—a kind of a semi-prepuce on oblique section, homologous to the "genital bulb" described in the other congeneric species (fig. 15).

Host.—*Megaceryle alcyon* (L.).

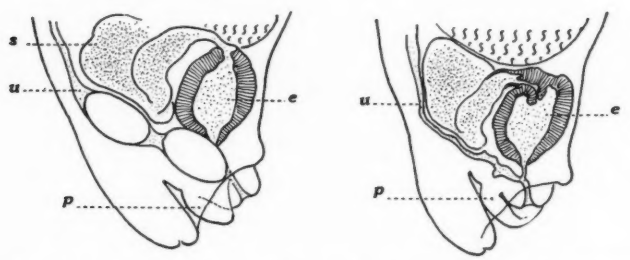

Fig. 15.—*Uvulifer semicircumcisus* n. sp., from *Megaceryle alcyon* (L.). Schematic drawing of the posterior extremity of the body.

Habitat.—Small intestine.

Distribution.—Pte. Mouillee (Lake Erie), Michigan.

Type.—Deposited in the collection of the Institut de Zoologie, Université de Neuchâtel.

This new species is distinctly differentiated by its very dimensions from *U. denticulatus* (Rudolphi) (Europe), from *U. cochlearis* (Verma) (India), and from *U. prosocotyle* (Lutz) (Brasil). It can not be confused with *U. gracilis* Yamaguti (Japan), of which the genital glands only occupy the last third or the last fourth of the posterior segment, which is deprived of vitelline follicles up to 1/6 or to 2/5 of its length. It is also differentiated from *U. ceryliformis* (Vidyarthi, 1938) Bhalerao, 1942, which has no ventral sucker. It approaches, on the contrary, *U. amboplitis* (Hughes) (United States), but differs from it by the fact that the second testis is always longer than the first, and by the maximum extension of the vitelline follicles into the posterior segment.[8]

Uvulifer magnibursiger n. sp.

Three examples of this species were found among specimens of *U. semicircumcisus*, taken from the same host specimen.

The total length of the body is 2.19 to 2.75 mm. The oval, anterior, cochleariform segment measures 0.45 to 0.48 mm long, by 0.21 to 0.24 mm wide; its posterior edge resembles a sigmoid valvule, being incurved ventrally to the height of the tribocytic organ. This has been distinctly seen on but one specimen, where it had an elliptical contour, with a large, transverse axis of 125 μ, and a small longitudinal axis of 98 μ; its center was situated at the 66th hundredth of the length of this part of the body. The claviform posterior segment begins with a narrow neck (90 to 170 μ in diameter), followed by an inflated part, occupied by the genital glands, and which contracts slightly up to the beginning of the spacious bursa copulatrix, delimited by a feeble constriction; it measures 1.71 to 2.25 mm in length, and presents its maximum width at the level of the first testis (0.34 to 0.42 mm). The attenuated extremity of the segment (0.21 to 0.24 mm in diameter)is rounded, except if the copulatory apparatus is evaginated, in which case it is dilated (0.33 mm in diameter) and conical, with an oblique truncation (fig. 17 B). The genital pore is subterminal, oriented at the dorsal side. The ratio of the length of the posterior segment to that of the anterior segment is 3.56 to 4.33.

As with the congeneric species, the oral sucker, measuring 53 to 64 μ long, by 85 to 91 μ wide, always larger than the acetabulum, projects at the extremity of the body. It is provided with a nearly spherical pharynx, of which the dimensions are 43 to 45 μ antero-posteriorly and 41 to 50 μ transversely. The ventral sucker, situated at the 56th hundredth of the length of the segment (observed in only a single specimen) has a diameter of 35 to 38 μ.

8 We have not received the work of Pande, where *Uvulifer stunkardi* (Pande, 1938) Bhalerao, 1942, is described.

The ellipsoidal ovary is situated at the mid-length of the posterior segment (45/100 to 55/100); it measures 105 to 135 μ in the longitudinal dimension, and 125 to 153 μ in width. The vitelline glands begin toward the middle of the neck, and extend to just in front of the bursa copulatrix, which is always exposed. The vitelline reservoir is inter-testicular. The single egg seen in the uterus measured 95 by 66 μ.

The rounded, unlobed testes are equal. The first, of which the anterior margin is situated between the 47th and the 57th hundredths of the length of the segment, measures 225 to 260 μ long, by 270 to 295 μ wide; it is contiguous with the second, of which the posterior margin is located between the 75th and the 83rd hundredths of its length, and of which the dimensions are 225 to 270 μ by 270 to 285 μ. The seminal vesicle is continued by a dorsal ejaculatory pouch, 160 μ long by 100 μ wide, with a thick wall of 15 to 25 μ. The common genital canal traverses a genital cone concealed by a very muscular bursa copulatrix, 315 to 325 μ long, ovoid at the time the cone is retracted (itself having a height of 100 μ and a diameter of 80 μ at the base, cf. fig. 17 A), and a depth of 135 to 180 μ, according to whether one measures it from the dorsal lip, or from the ventral lip of the sexual pore. On the contrary, when the genital cone is evaginated (having a height of 160 μ, and a diameter of 145 μ at the base, cf. fig. 17 B—it appears then to be enveloped ventrally by a prepucial fold 160 to 180 μ high, by 45 to 50 μ in thickness, comparable to that of *U. semicircumcisus*), the bursa copulatrix 245 μ deep, opens wide, allowing the dilated summit of the organ to project, of which non-exsertile part, retained in the extra-bursal parenchyma, forms a muscular spherical mass, very apparent and of a diameter of 160 μ.

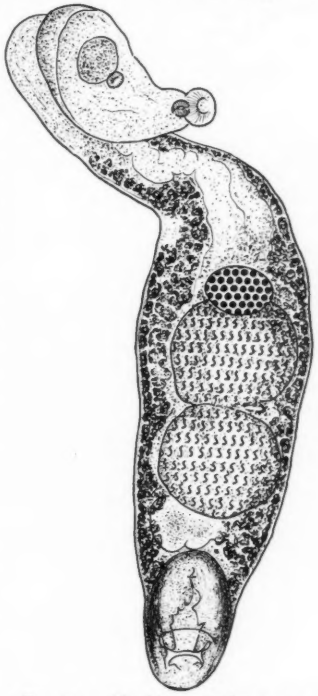

Fig. 16. — *Uvulifer magnibursiger* n. sp., from *Megaceryle alcyon* (L.). Dorsal view of posterior segment. Length: 2.19 mm.

This species is distinguished from its congeners by the excessive development of the copulatory apparatus.

Host.—*Megaceryle alcyon* (L.).

Habitat.—Small intestine.

Distribution.—Pte. Mouillee (Lake Erie), Michigan.

Type.—Deposited in the collection of the Institut de Zoologie, Université de Neuchâtel.

Note on the genus Uvulifer Yamaguti.—This genus was established for a single species, *U. gracilis* Yamaguti, 1934. According to the describer, the genotype is characterized essentially by the presence of an "uvula-like muscular appendage," situated in the bursa copulatrix. We believed we had found this uvuliform organ in *Hemistomum denticulatum* (Rud.), which we consequently attributed to the genus *Uvulifer* (cf. Dubois, 1937c, p. 126; 1938, pp. 322-325 and fig. 219). The observations made on the two new species, described above, have led us to re-undertake the examination of *U. denticulatus* (Rud.), collected by Fuhrmann, and deposited in our collection.

We have seen that the genital cone was also half enveloped by a prepucial fold, ventrally disposed; this, in optical section, has indeed the appearance of an uvula, and by analogy, of the structure with an homologous formation and characteristic of *Cotylurus* Szidat, we have called it "genital bulb." Moreover, in considering the figure 223 of the *Monographie des Strigeida,* representing the posterior extremity of *U. prosocotyle* (Lutz), we confirm that a prepucial fold has been observed, although we had not mentioned it as such, not being able to furnish at the moment (1938) an adequate interpretation of this anatomical peculiarity. It is probable that the other congeneric species possess likewise this fold, rather than a "bulb."

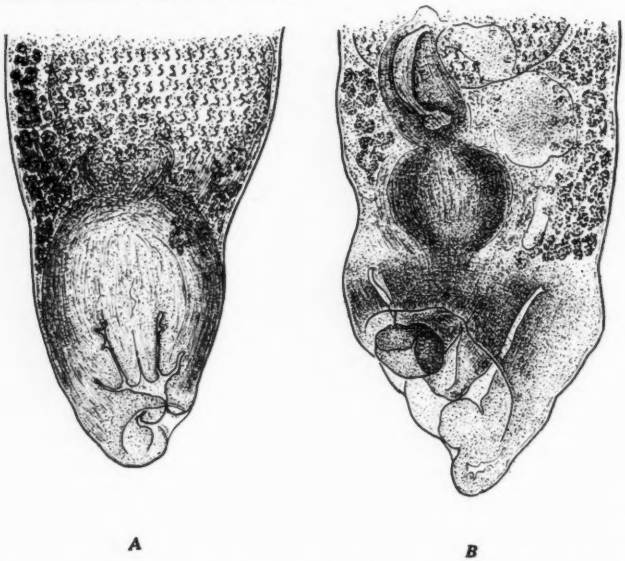

Fig. 17.—*Uvulifer magnibursiger* n. sp., from *Megaceryle alcyon* (L.). A) Bursa copulatrix retracted. B) Bursa copulatrix expanded.

This exposition constitutes a new justification of the idea of a derivation of the genus *Uvulifer* Yamaguti beginning with *Posthodiplostomum* Dubois (cf. Dubois, 1944, pp. 84-86, and diagram 3). In fact, all the representatives of this last genus possess a protractile bursa copulatrix, of which the fold of the retractile walls constitutes a prepuce completely surrounding the genital cone. Now, the evolutionary process, attested by the progressive retreat of the anterior limit of the vitelline glands which tend to, and finally succeed in confining themselves to the posterior segment, would have obtained at the same time the reduction of the preputial cylinder of the dorsal side.

ADDENDUM

DIPLOSTOMUM MICRADENUM (Cort and Brackett)

This worm was experimentally obtained by Olivier (1940) in the domestic pigeon, from the larva *Cercaria micradena* Cort and Brackett, 1938, harbored by *Stagnicola palustris elodes* (Say), and developing into a diplostome in the central nervous system of the tadpole of *Rana pipiens* Gm. The exceptional quality of the original material and of its staining leads us to reveal one of its aspects.

The adult measures, according to Olivier, 10.4 to 1.35 mm in total length (average: 1.15 mm). The specimen which we represent has precisely this average dimension. Its width, in front, attains 0.51 mm. The bisegmentation of the body is marked by but a feeble transverse constriction, or, as it is in the case of this example, by a perceptible diminution of the width of the body (see also Olivier, pl. I, fig. 12). Thus delimited, the anterior segment, "round to oval, concave ventrally" is slightly shorter than the hind-body." Our drawing shows its strong concavity — the posterior border concealing a good part of the tribocytic organ.

The ventral sucker (95 by 112 μ), situated rather near the middle of this segment, is larger than the oral sucker (95 by 97 μ); but as Olivier remarked (pp. 457-458), its antero-posterior diameter (80 μ) is equal to that of the oral sucker. The pharynx measures here 75 by 65 μ; the median ovary, 70 by 120 μ; the first testis, asymmetrically developed, resembling in shape a shoe, 190 by 260 μ; the second testis, of which the posterior border is situated at the 63rd

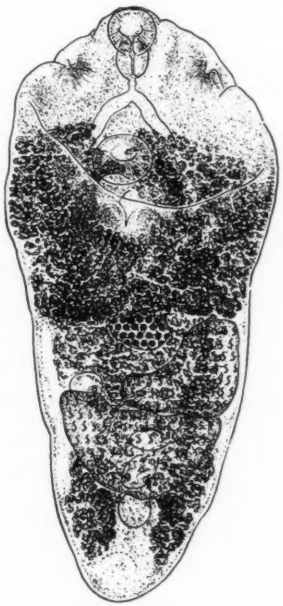

Fig. 18. — *Diplostomum micradenum* (Cort and Brackett), from the pigeon (type material, U. S. N. M., Helm. Coll., no. 36701). Length: 1.15 mm.

hundredth of the length of the segment, 160 to 180 μ by 305 μ.

The vitelline follicles have their maximum density in the anterior segment, where they extend hardly beyond the ventral sucker (limit to the 42/100). From the beginning of the posterior segment, they are less abundant, covering the ventral face and forming two lateral masses behind the second testis; these terminate at the height of the curved border of the dorsal and subterminal genital pore. In considering the rather abrupt change of density of the follicles at the intersegmentary level, one finds that the posterior segment is, to the contrary of what has been said, slightly shorter than the anterior. The uterus contained 3 or 4 eggs, not measurable.

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The Helminth Parasites of Birds. I. A Review of the Trematode Genus Tanaisia Skrjabin, 1924[1]

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During the past several years the authors have taken an occasional specimen of a trematode from the urinary tract of various species of birds from the southeastern section of the United States. These trematodes were tentatively identified as belonging to the genera *Tanaisia* Skrjabin, 1924, and *Tamerlania* Skrjabin, 1924, family Eucotylidae Skrjabin, 1924, and were held in reserve for further study. Lately, however, the authors have had occasion to make more extensive and concentrated surveys of the parasites of birds from two rather widely separated localities, one in Texas, conducted by the junior author, and the other in North Carolina and Virginia, conducted by the senior author. The results of these collections have revealed the presence of urinary tract inhabiting flukes in 28 specimens of birds belonging to 13 species, 8 families and 3 orders. A total of 120 specimens of the 13 species of birds has been examined for these trematodes. A summary of the incidence of infection in these bird hosts for this particular group of trematodes is given in Table I.

The family Eucotylidae was proposed by Skrjabin (1924) for the reception of the genera *Eucotyle* Cohn, 1904, *Tanaisia* Skrjabin, 1924, and *Tamerlania* Skrjabin, 1924. Since the erection of the family Eucotylidae, three additional genera, *Ohridia* and *Lepidopteria*, proposed by Nezlobinsky (1926) and *Proshystera*, proposed by Kozkhaus (1930), have been created for the reception of urinary tract inhabiting flukes and placed in this family.

As outlined by Skrjabin the family Eucotylidae was characterized as follows: Medium-sized monostomes with subterminal oral opening, pharynx, and intestinal ceca extending posteriorly to near caudal end of body. Esophagus present or absent. Genital opening behind bifurcation of ceca. Cirrus sac absent. Seminal vesicle and ovary in advance of testes; testes extracecal or intracecal, diagonal to each other or at same level, in second third of body length. Vitellaria lateral to ceca, beginning a short distance behind anterior end of body or at level of testes, generally commencing at same level and terminating at same level. Uterus forming crisscross coils in descending, reaching

1 Results of research supported in part by 1) Graduate School, University of Georgia, Athens, Georgia; 2) Mountain Lake Biological Station, Mountain Lake, Virginia; 3) The Minnie D. Warren Scholarship, Highlands Museum and Biological Laboratory, Inc., Highlands, North Carolina; and 4) The University Center, Atlanta, Georgia, to whom the senior author wishes to express his sincere appreciation.

posterior end of body before ascending by similar course to genital pore, forming a net-like pattern in passing through its course. Ova small, numerous, without filament. Parasitic in kidney and urinary tracts of birds.

Since the genus *Eucotyle* Cohn, 1904, is designated the type genus of the family Eucotylidae, it is necessary to consider briefly the diagnostic features of this genus. These diagnostic characters are as follows: Elongated, flattened, medium-sized monostomes with anterior end somewhat triangular and set off from remainder of body by a dorsal and ventral transverse muscular collar; posterior end rounded. Testes opposite each other, either entirely extracecal, partly overlapping ceca or mostly intracecal with median borders touching, irregular in outline. Ovary lobate, pretesticular, and to one side of midline. Vitellaria extracecal, commencing immediately posterior to transverse muscular collar and extending to or beyond testes. Parasitic in kidney of water birds.

On the other hand, the genera *Tanaisia* and *Tamerlania* of Skrjabin (1924) are so nearly identical from the standpoint of diagnostic characters, as outlined in the original descriptions, that the following summary of characters will suffice to point out the major differences between them and the genus *Eucotyle:* Medium-sized monostomes with elongated body; anterior end being continuous with remainder of body and not set off by a dorsal and ventral transverse muscular collar. Esophagus present (*Tanaisia*) or absent (*Tamerlania*). Ceca extending to near posterior extremity. Testes strongly lobed and diagonal to each other (*Tanaisia*) or round with entire margins and at same level, (*Tamerlania*), in middle third of body length. Ovary pretesticular, strongly lobed (*Tanaisia*) or round with entire margin (*Tamerlania*). Vitellaria mostly extracecal, in middle third of body. Parasitic in urinary tract of water birds (*Tanaisia*) or non-aquatic birds (*Tamerlania*).

During the course of our investigation no specimen of fluke has been met with which could be assigned to the genus *Eucotyle*. Except for the purpose of comparison between material studied by the authors and published accounts of the species of *Eucotyle*, trematodes of this type will not enter into the plan of the present paper.

Following the creation of the genus *Tanaisia* by Skrjabin (1924), Issaitschikov (1926) studied material identified as *T. fedtschenkoi* Skrjabin, 1924, the type and only species of the genus, and emended the generic diagnosis to include the union of the ceca near the posterior end of the body. Nezlobinsky (1926) added a second species to the genus, *T. elliptica*. A third species was described under the name of *T. pelidnae* by Cheatum (1938).

The genus *Tamerlania* was created by Skrjabin (1924) for the reception of a single species, *T. zarudnyi*, from birds taken mainly from Russian Turkestan. Khitrowo-Kalantarian (1925) studied flukes identified as *T. zarudnyi* and observed the union of the ceca near the posterior extremity of the body. Nezlobinsky (1926) described the second species of the genus *T. meruli*, from the European blackbird taken in the Macedonia region of Yugoslavia. Santos (1934) added a third species, *T. bragai*, from the domestic pigeon in Brazil.

Santos emended the generic diagnosis to include the forward extension of the vitellaria, which in his species commenced well in advance of the level of the ovary. Shtrom (1935) identified material from birds of Turkestan as *T. zarudnyi* and called attention to the presence of a ventral sucker in his material. Shtrom questioned for the first time the advisability of including the genera *Tanaisia* and *Tamerlania* in the Monostomata. Yamaguti (1935), working with specimens obtained from birds in Japan, described *T. japonica*. Later this same worker (1941) collected additional material of his species from another bird host and concluded from a study of these specimens and from a restudy of the original material that *T. japonica* was synonymous with *T. zarudnyi* Skrjabin. *Tamerlania melospizae* was added to the generic group by Penner (1939) as a result of material collected from a sparrow in Minnesota, U. S. A. The last species to be added to the genus was described by Dollfus (1946) under the name of *T. gallica*. The material studied by Dollfus came from birds in France. In an addenda to his paper Dollfus declared his species to be a synonym of *T. zarudnyi*.

The discovery of an acetabulum in specimens identified as *Tamerlania zarudnyi* by Shtrom (1935) has been overlooked until Dollfus (1946) called attention to Shtrom's work. However, Maldonado (1943) observed a definite ventral sucker in all of the cercariae developing in the land snail, *Subulina octona*, which he experimentally infected with ova from *T. bragai* Santos. He states: "This organ (acetabulum), however, atrophies during development in the final host, but occasionally may be retained in a rudimnetary form by the adult." Later, Maldonado (1945) reconfirmed his earlier findings concerning the presence of the acetabulum and completed the life cycle of the species. From material of the same species, and supplied by Maldonado, Stunkard (1945) added significant details to the description of the form and confirmed Maldonado's observation on the presence of the acetabulum in the adult *T. bragai*.

Two genera, *Ohridia* and *Lepidopteria*, were added to the family group by Nezlobinsky (1926). Trematodes from the urinary tract of birds from the Macedonia region of Yugoslavia constituted the source material for these two genera. In general the critical points in the generic diagnosis of the first of these two genera, *Ohridia*, are a short esophagus without dilation, diagonal, smooth bordered testes, a round ovary with finely serrated margin and a large pharynx. The union of the ceca was not observed. Penner (1939) stated: "The only difference noted between *Tamerlania* and *Ohridia* is in the position of the testes and it is very possible that the lone species, *O. panuri* Nezlobinsky, 1926, should be included in *Tamerlania*." Although Penner was of that opinion he retained the genus *Ohridia*, pending further study of the group.

The genus *Lepidopteria*, as defined by Nezlobinsky (1926), differed from the other genera of the group in the shape of the ovary. The ovary is described as being more or less "butterfly-shaped," with two anterior and two posterior lobes, either lobe of which in turn may be sub-lobed, or both lobes may bear secondary lobes. Three species were described as comprising the

genus, *L. atra,* from the European Coot, *L. plegadis,* from an Ibis, and *L. graciosa,* from the Wagtail.

Korkhaus (1930) defined a new genus and species, *Proshystera rossittensis,* from material obtained from the crow, *Corvus cornix,* in Germany. Ejsmont (1931, 1932) studied specimens from the same host and concluded that the genus and species as proposed by Korkhaus were synonymous with *Tanaisia fedtschenkoi* Skrjabin. The present writers are in complete agreement with Cheatum (1938) and Dollfus (1946) in accepting Ejsmont's opinion.

The material at our disposal consists of one hundred and thirty-one specimens of flukes which readily fall into the *Tanaisia-Tamerlania* group. In making a detailed study on these worms, both from sections and whole mounts, the authors are of the opinion that a single genus should encompass the entire group of described genera and species of the *Tanaisia-Tamerlania-Ohridia-Lepidopteria* complex. The basis for this opinion is given in the discussion. Going on the assumption that the author's opinion is a correct one, the question of the proper designation of the genus can be decided on the basis of page priority. In creating the family Eucotylidae, Skrjabin (1924) logically considered the type genus, *Eucotyle* Cohn, 1904, in the first part of the paper, pages 81-84. The second genus to be considered was *Tanaisia,* pages 84-86. The diagnosis of the genus *Tamerlania* occurred on page 86. Thus, by page priority the appropriate name for the genus under discussion is *Tanaisia* Skrjabin, 1924. From a study of the material available to us we are further of the opinion that no more than four species of the genus *Tanaisia* can be recognized, namely: *T. fedtschenkoi* Skrjabin, 1924, *T. zarudnyi* (Skrjabin, 1924), nov. comb., *T. atra* (Nezlobinsky, 1926), nov. comb., and *T. bragai* (Santos, 1934), nov. comb. All four of these species are present in our collection. Their general morphology as observed by the authors can be summarized as given below.

1. TANAISIA FEDTSCHENKOI Skrjabin, 1924

Plate I

Syn: Tanaisia fedtschenkoi Skrjabin, 1924, p. 85; *Ohridia panuri* Nezlobinsky, 1926, p. 206; *Tanaisia elliptica* Nezlobinsky, 1926, p. 211; *Proshystera rossittensis* Korkhaus, 1930, p. 293; and *Tanaisia pelidnae* Cheatum, 1938, p. 136.

Small to medium-sized distomate flukes, with rounded ends and almost parallel borders. Body flattened dorso-ventrally, weakly muscular, measuring 2.75 (1.62 to 3.46) mm long by 0.59 (0.41 to 0.71) mm wide, usually widest at or just behind level of testes. Cuticular spines present throughout entire body length. Oral sucker subterminal, well developed, 0.18 (0.13 to 0.22) mm long by 0.23 (0.17 to 0.29) wide. Prepharynx absent. Pharynx muscular, 0.08 (0.05 to 0.09) mm long by 0.10 (0.08 to 0.14) mm wide, about one-third to one-half exposed at caudal margin of oral sucker. Small cluster of deeply staining cells in area adjacent to caudal margin of pharynx, suggestive of peri-pharyngeal or peri-esophageal gland cells; cells inconspicuous in specimens mounted *in toto.* Esophagus short (34 to 93 μ), thin-walled, some-

times with conspicuous dilation immediately behind pharynx; wall non-muscular, lined with same type of cells lining lumen of ceca; esophagus may or may not show up in whole mounts. Ceca relatively slender, slightly undulating tubes, diverging laterally and posteriorly from bifurcation, passing posteriorly near lateral margins of body, fusing together to form completed arch at a level approximating one-sixth to one-ninth body length from posterior end of body: usually containing a yellowish, granular-like fluid. Acetabulum sometimes present in fully matured specimens (present in so far as could be determined in a single mounted specimen from Wilson's Snipe: located immediately behind level of testes and measured 54 μ long and 84 μ wide). Testes occupy a position anywhere from caudal portion of anterior third of body to anterior half of second body third; from slightly diagonal (Pl. I, Fig. 2) to a tandem position (Pl. I, Figs. 3 and 6); highly irregular in outline to deeply lobed; difficult to measure, measuring approximately 0.20 (0.15 to 0.29) mm long by 0.17 (0.10 to 0.21) mm wide for right and 0.22 (0.13 to 0.30) mm long by 0.17 (0.10 to 0.22) mm wide for left testis; testis on ovarian side of body more posterior in position. Vasa efferentia unite to form short vas deferens before entiring cirrus sac. Cirrus sac globular in shape, measuring up to 85 μ in maximum width, containing a short, thin-walled vesicula seminalis, a few prostatic gland cells and a short cirrus. A common genital atrium serves both male and female tubes; it is median in position, at or just in front of anterior level of ovary. Vitelline glands lateral in position, lateral and dorsal to ceca, from about level of caudal margin of ovary to near union of ceca, having about same distribution on either side of body although one gland may be a little less extensive or one may show evidence of atrophy at one or other limits of distribution. Transverse vitelline ducts emerge from anterior ends of glands and fuse together medially to form small yolk reservoir. Ovary usually deeply lobed, with six or more main lobes, each of which may bear protuberances, giving ovarian mass appearance of being semi-dendritic in form; may be quite compact (Pl. I, Fig. 7) in which lobed condition is not so obvious as in other specimens (Pl. I, Figs. 1 and 4): it may lie to right or left of midline at or anterior to junction of first and second body thirds, 0.69 (0.46 to 0.91) mm behind anterior end of body, and measures 0.21 (0.15 to 0.28) mm long and 0.19 (0.14 to 0.27) mm wide. Oviduct arises from median margin, at about middle of long axis, of ovary and passes along midline to about level of caudal margin of ovary before swinging to opposite side of body from ovary where it forms ootype. Shell gland large, filling most of body between midline and cecum posterior to caudal boundary of ovary. Receptaculum seminis occupies space immediately behind ovary. No trace of Laurer's canal was observed. Yolk reservoir small, median in position, just caudal to level of ootype. Uterus descending through a profusion of coils to posterior end of body before turning anteriorly and ascending by a similar course to region of intestinal bifurcation, from whence it descends to genital pore, forming a short, muscular metraterm before entering pore; uterus frequently passes out laterally far enough to overlap ceca in descending and ascending. Ova rather thick-shelled, dark-brown in color, operculated, slightly flattened on one side and fully em-

bryonated before being oviposited: they measure 33 to 38 μ long by 10 to 19 μ wide.

Hosts from present survey.—Killdeer, *Oxyechus vociferus vociferus* (L.), Wilson's Snipe, *Capella delicata* (Ord) and Rusty Blackbird, *Euphagus carolinus* (Muller).

Habitat.—Urinary tract.

Locality.—Texas and Georgia, *U. S. A.*

2. **Tanaisia zarudnyi** (Skrjabin, 1924), nov. comb.
Plate II and Plate III, Fig. 17

Syn: Tamerlania zarudnyi Skrjabin, 1924, p. 86; *Tamerlania meruli* Nezlobinsky, 1926, p. 213; *Tamerlania japonica* Yamaguti, 1935, p. 170; *Tamerlania melospizae* Penner, 1939, p. 422; and *Tamerlania gallica* Dollfus, 1946, p. 42.

Small to medium-sized distomate flukes, with rounded extremities and almost parallel sides. Body dorso-ventrally flattened, weakly muscular, measuring 2.46 (1.94 to 3.23) mm long by 0.52 (0.40 to 0.66) mm wide, being widest at or caudal to level of testes. Cuticular spines present throughout entire length of body. Oral sucker subterminal, well developed, measuring 0.20 (0.13 to 0.29) mm long by 0.23 (0.16 to 0.32) mm wide. Prepharynx absent. Pharynx muscular, one-third to one-half exposed at caudal margin of oral sucker, 0.09 (0.06 to 0.12) mm long by 0.10 (0.07 to 0.14) mm wide. Esophagus short, up to 42 μ in length (in living worms the esophagus may become quite a distinct feature of the digestive tract), lined with same type epithelium as that lining ceca. Ceca thin-walled, slightly undulating, following parallel to lateral margins of body to near posterior end where they become fused together, forming completed arch from one-sixth to one-tenth body length from posterior end, containing a pale yellowish, granular-like fluid. Acetabulum may or may not be present in fully mature individuals; present and functional in all immature forms (Pl. II, Fig. 12); measuring 40 μ in diameter in specimens only 450 μ in length and as little as 44 μ in diameter in specimens 2.50 mm in length (Pl. II, Fig. 11). Testes close (50 to 100 μ) behind ovary, from round with smooth margins to highly irregular in shape, generally opposite each other although one may be slightily more advanced (testis on ovarian side of the body is usually the more caudal in position); they measure 0 13 (0.07 to 0.20) mm long by 0.12 (0.07 to 0.22) mm wide for right and 0.13 (0.08 to 0.20) mm in diameter for left testis. Vasa efferentia uniting to form vas deferens before entering cirrus sac. Genital pore ventral, median, at or near level of cephalic margin of ovary. A common genital atrium serves both male and female ducts. Metraterm short, leads uterus into genital atrium. Cirrus sac globular to pyriform in shape, 60 to 85 μ in length, dorsal and caudal to genital pore, containing a slightly muscular cirrus, a short duct surrounded by prostatic gland cells and a slightly dilated seminal vesicle. Vitelline glands lateral and dorsal to ceca, from a level approximating cephalic borders of testes to a level approximating one-half the distance from point of origin to caudal extremity of body, terminating from 0.85 to 1.26 mm behind level of ovary or 0.43 to 1 06 mm in front of caudal extremity of body, usually

of same distribution on each side of body although one gland may commence or terminate a little in advance of other. Transverse yolk ducts emerge from cephalic ends of vitelline glands and pass medially to fuse together, forming a small, median yolk reservoir. Ovary in front of testes, usually to left of midline, from round with smooth margin (Plate III, Fig. 17) to irregular in shape (sometimes with dendritic-like lobation (Pl. II, Fig. 15))—(In certain specimens the ovary, both in whole mounts and in sectioned material, becomes vacuolated, with several small vesicle-like cavities dispersed among the germinal portions (Pl. II, Figs. 8, 9, 13 and 14 and Pl. III. Fig. 17), giving the ovary an appearance of being highly irregular in shape); ovarian mass measures 0.14 (0.08 to 0.21) mm long by 0.16 (0.13 to 0.23) mm wide and lies 0.64 (0.51 to 0.77) mm behind anterior margin of body. Oviduct arises from median aspect of mesal margin of ovary and swings to opposite side of body from ovary to form ootype and shell gland laterally and caudally to hinder margin of ovary. Seminal receptaculum small, immediately behind ovary, often separating ovary from testis on ovarian side of body. Yolk reservoir median in position, behind level of shell gland-ootype complex. Uterus coils and winds its way posteriorly to caudal extremity of body before turning anteriorly to follow a similar course to level of pharynx and bifurcation, whence it turns posteriorly once more to coil its way down to genital pore, often overlapping ceca throughout its course. Ova numerous, rather thick-shelled, operculated, slightly flattened on one side, fully embryonated before being oviposited (Pl. II, Fig. 10), measuring 32 to 50 μ long by 25 to 32 μ wide: frequently ova appear to be almost round in shape and measure 32 to 34 μ by 25 to 30 μ wide. Unhatched miracidium ciliated, with several developing germ-balls and an anterior pair of rather large gland cells.

Hosts from present survey.—Southern Parula Warbler, *Compsothlypis americana americana* (L.), Red-eyed Towhee, *Pipilo erythrophthalmus erythrophthalmus* (L.), Alabama Towhee, *P. erythrophthalmus canaster* Howell, Hermit Thrush, *Hylocichla guttata* (Pallas), White-throated Sparrow, *Zonotrichia albicollis* (Gmelin) and Florida Blue Jay, *Cyanocitta cristata florincola* Coues.

Habitat.—Urinary tract.

Locality.—Texas, Georgia, North Carolina and Virginia, U.S.A.

3. **Tanaisia atra** (Nezlobinsky, 1926), nov. comb.
Plate III, Figs. 18, 19 and 20

Syn: Lepidopteria atra Nezlobinsky, 1926, p. 208; *Lepidopteria plegadis* Nezlobinsky, 1926, p. 209; and *Lepidopteria graciosa* Nezlobinsky, 1926, p. 210.

Small to medium-sized (distomate?) flukes, with rounded extremities and almost parallel sides. Body dorso-ventrally flattened, weakly muscular, measuring 1.06 (0.92 to 1.25) mm long by 0.22 (0.15 to 0.27) mm wide, widest behind level of testes. Cuticular spines present throughout entire length of body. Oral sucker subterminal, muscular, 0.09 (0.08 to 0.10) mm long by 0.12 (0.10 to 0.15) mm wide. Phepharynx absent. Pharynx muscular, one-

fourth to two-thirds exposed behind oral sucker (Pl. III, Fig. 20), measuring from 40 to 52 μ in diameter. Esophagus variable, up to 42 μ in length, sometimes with marked dilation (36 μ in width). Ceca pass posteriorly parallel to lateral margins of body, fusing together to form completed arch about one-tenth body length in front of posterior extremity of body, containing yellowish, granular-like fluid in living specimens. Acetabulum unobserved. Testes posterior to ovary, in second third of body length, diagonal (in which caudal testis overlaps posterior limits of more cephalic testis) to tandem (in which one testis is entirely caudal to the other one) in position, with anterior testis at least one-half its diameter (usually more) behind level of ovary, highly irregular in outline and measure approximately 0.06 mm long by 0.05 mm wide. Cirrus pouch dorsal and posterior to genital pore, globular, containing short cirrus and small seminal vesicle, measuring 40 to 50 μ in diameter. Genital pore median and ventral, at or just below level of cephalic margin of ovary. A common genital atrium serves both male and female tracts. Vitellaria lateral and dorsal to ceca, consisting of numerous small follicles, beginning at level of caudal margin of ovary and terminating a very short distance in front of union of ceca. Transverse yolk ducts emerge from cephalic ends of glands and pass medially to fuse together, forming small yolk reservoir caudally to shell gland-ootype complex. Ovary in advance of testes, in posterior portion of first third of body, usually median in position, with a broad basal portion and two anteriorly directed major lobes; lobes and basal portion may bear secondary lobes. When ovary is median in position the genital pore is located near basal part, between two anterior lobes. When ovary is more lateral in position its lateral and caudal margins are strongly lobed while the median margin curves around area of genital pore, giving that margin of ovary an hollowed-out appearance. Even when main body of ovary is more lateral in position a median piece can be seen extending beyond plane of genital pore. Approximate measurements for ovary are: 0.09 (0.08 to 0.10) mm long by 0.11 (0.08 to 0.13) mm. wide. Ovary lies about 300 μ behind anterior extremity of body. Oviduct arises from median border of basal portion of ovary and passes dorsally and posterio-laterally to give rise to shell gland and ootype in area to right of midline immediately posterior to level of ovary. A rather large, pear-shaped seminal receptaculum occupies area just behind ovary to left of shell gland. Uterus greatly coiled, descending to posterior extremity of body before turning anteriorly, ascending to level of pharynx from whence it turns posteriorly to descend to genital pore, frequently overlapping ceca in descending and ascending, completely masking ceca anterior to level of ovary. Ova numerous, rather thick-shelled, operculated and fully embryonated before being oviposited, measuring 22 to 34 μ long and 15 to 19 μ wide.

Host from present survey.—American coot, *Fulica americana americana* Gmelin.

Habitat.—Urinary tract.

Locality.—Georgia, U.S.A.

4. **Tanaisia bragai** (Santos, 1934), nov. comb.

Plate III, Figs. 21, 22 and 23

Syn: Tamerlania bragai Santos, 1934.

Small to medium-sized distomate flukes, with rounded extremities and almost parallel sides. Body dorso-ventrally flattened, weakly muscular and measures 1.99 (1.62 to 2.55) mm long by 0.42 (0.32 to 0.53) mm wide, greatest width occurring at or just posterior to level of testes. Cuticular spines present throughout entire length of body. Oral sucker subterminal, well developed, measuring 0.17 (0.13 to 0.20) mm long by 0.19 (0.14 to 0.23) mm wide. Prepharynx absent. Pharynx muscular, one-third to one-half exposed behind oral sucker, measuring 0.06 (0.04 to 0.08) mm long by 0.08 (0.06 to 0.09) mm wide. Peri-esophageal or peri-pharyngeal gland cells about caudal limits of pharynx. Esophagus variable, measuring up to 170 μ in length, non-muscular, without marked dilation, lined internally with same type of epithelium as that lining ceca. Ceca slightly dilated tube, paralleling lateral margins of body to near posterior end where they fuse together, forming completed arch one-fifth to one-eighth of body length from posterior end. Acetabulum unobserved in present material. Testes posterior to ovary, at or in advance of body middle, opposite each other or slightly oblique in position, in close apposition to ceca, with testis on ovarian side of body slightly more posterior, irregular in shape, sometimes with strong indentations, measuring 0.12 (0.09 to 0.15) mm long by 0.10 (0.07 to 0.15) mm wide for right and 0.13 (0.09 to 0.18) mm long by 0.11 (0.08 to 0.15) mm wide for left. Vasa efferentia uniting to form a very short, rather thick-walled vas deferens before entering cirrus sac. Cirrus sac small, thin-walled, lying dorsal and posterior to genital pore, containing short, stout cirrus, prostatic gland cells and slightly dilated seminal vesicle, measuring as much as 88 μ in length by 60 μ in maximum width. Genital pore ventral, median in position, at or below level of cephalic margin of ovary. A common genital atrium serves both male and female ducts. Vitelline glands follicular, lateral and dorsal to ceca, extending from level 0.22 (0.06 to 0.34) mm in advance of ovary (from one-ninth to just less than one-half the distance from ovary to the anterior end of body) to a level approximating one-half the distance from ovary to posterior end of body; follicles may be more extensive on one side of body. Transverse yolk ducts emerge from glands at about level of anterior limits of testes. Ovary usually to left of midline, 0.58 (0.47 to 0.67) mm behind cephalic margin of body and about one-half its own diameter in advance of testis on ovarian side of body, varying in shape from round with smooth border to an irregularly shaped, rather deeply indented body, measuring 0.18 (0.15 to 0.20) mm long by 0.14 (0.10 to 0.19) mm wide; sometimes with vacuole-like spaces in mass of ovary. Oviduct originates from middle of median margin of ovary, passing dorsally and posterio-laterally to give rise to ootype and shell gland. Shell gland large, occupying area of body dorso-laterally and caudally to ovary from about level of caudal third of ovary to a level about one-half the length of ovary behind

that body. Receptaculum seminis small, immediately behind ovary. Yolk reservoir median in position, at level of shell gland. Uterus greatly coiled, passing to extreme posterior end of body before turning anteriorly, ascending to level of pharynx where it turns posteriorly to descend to genital pore. A short, thick-walled metraterm is seen in sectioned specimens. Uterus frequently passes out laterally far enough to overlap ceca in ascending and descending. Ova numerous, rather thick-shelled, dark-brown in color, operculated and fully embryonated before being oviposited, measuring 30 to 34 μ long by 16 to 22 μ wide.

Hosts from present survey.—Bronzed Grackle, *Quiscalus quiscula aeneus* Ridgway, Swainson's Warbler, *Limnothlypis swainsoni* (Audubon), and Ovenbird, *Seiurus aurocapillus* (L.).

Habitat.—Urinary tract.

Locality.—Texas, Georgia and Virginia, U.S.A.

DISCUSSION

During the course of the present investigation thirteen species of birds have been found to harbor members of the genus *Tanaisia* in that portion of the urinary tract which lies adjacent to the kidneys. In no instance was the parasite observed to be outside of the urinary tract although they were found occasionally in the smaller branches of the tract, adjacent to the substance of the kidney. In a few instances a marked dilation of the tubule at the site of the worm was observed, and frequently a thick, pearly-like detritus was observed in the parasitized tubule, often to the distention of the tubule, and more often than not there occurred a central core of a coarse, black pigmented substance in association with this material. When such material was present, the parasitized tubule was distended to the point that expulsion of the substance and parasite was most difficult: the tubule ruptured too readily for ease in expressing the contents.

Table I summarizes the intensity of the infection with *Tanaisia* in the parasitized birds studied during the present survey.

From a study of the parasitic material taken from birds of the region covered by the present survey, supplemented by a careful review of the literature pertaining to this group of trematodes, the writers are convinced they are dealing with a single genus, *Tanaisia* Skrjabin, 1924. The marked similarity of form and organization of anatomical details which is observed in this group of flukes is apparent immediately even to the casual observer.

It will be recalled that Skrjabin (1924) separated the genus *Tanaisia* from the genus *Tamerlania* on the basis of presence or absence of the esophagus, the lobed or non-lobed borders of the testes, the opposite or diagonal position of the testes and the type of host (aquatic or non-aquatic) from which the parasites came. In considering the indicated differences between the two original genera as defined by Skrjabin, similarities of structure and of hosts must be taken into account. Numerous contributions to our knowledge of the group

have been made since Skrjabin defined these genera, and each contributor has added considerable information pertinent to the group as a whole. The first two such contributions were made by Khitrowo-Kalantarian (1925) and Issaitachikov (1926), in which the former discovered the union of the ceca in the posterior part of the body in members of the genus *Tamerlania* and the latter discovered that the same phenomenon occurred in members of the genus *Tanaisia*. In reference to the fusion of the ceca near the posterior extremity of the body it is essential only that the writers point out the fact that with the exceptions of *Tamerlania elliptica* Nezlobinsky, 1926, and *Ohridia panuri* Nezlobinsky, 1926, this fusion of the ceca within the group is the rule rather than the exception: in every instance where the species has been studied from a sufficiently large series the ceca have been observed to unite. Thus, due to the very striking similarity of form in respects to all other characters, noted for every member of the group, the writers are of the opinion that the ceca unite in those individuals in which the fusion was not observed by the original investigator.

In consideration of the presence or absence of the esophagus references from the literature are about evenly divided between "present" and "absent" schools. On the other hand, those few contributors who have referred to the living worms in describing the nature of the anatomical parts invariably men-

TABLE I.—The hosts, incidence of infection and number of parasites recovered during the present survey.

Name of parasite	Host species (Common name)	Number examined	Number infected	Per cent infected	Number of worms
Tanaisia fedtschenkoi Skrjabin, 1924	Killdeer	4	1	25.0	10
	Wilson's Snipe	1	1	100.0	20
	Rusty Blackbird	7	3	42.8	10
Tanaisia zarudnyi (Skrjabin, 1924)	Parula Warbler	3	1	33.3	1
	Red-eyed Towhee	18	6	33.3	18
	Alabama Towhee	6	1	16.7	8
	Hermit Thrush	9	1	11.1	1
	Florida Blue Jay	16	4	25.0	21
	White-throated Sparrow	30	5	16.7	12
Tanaisia atra (Nezlobinsky, (1926)	American Coot	1	1	100.0	13
Tanaisia bragai (Santos, 1934)	Bronzed Grackle	12	1	8.3	8
	Swainson's Warbler	2	1	50.0	4
	Oven-bird	11	2	18.1	5
Total:	13 species	120	28	23.1	131

tioned the presence of an esophagus in the extended worm. In the material at hand this is definitely the case. A close examination of the mounted specimen will usually reveal the presence of a short portion of the digestive tract between the pharynx and bifurcation. If it is possible to accept such a species as *Tamerlania bragai* Santos, 1934, as being co-generic with *T. zarudnyi* Skrjabin, 1924, and the writers are convinced of this co-generic relationship, then the absence of the esophagus must definitely disappear from the generic diagnosis of the genus *Tamerlania,* and hence can no longer serve as a basis for the separation of this genus from the genus *Tanaisia.* In the material studied by Stunkard (1945) the esophagus in *T. bragai* was definitely defined in the extended specimens, and the esophagus is a very definite feature of the anatomy in Maldonado's (1945) illustrations of the young, maturing forms of the same species. The esophagus was observed to pass through as many as twenty-one sections (8 μ in thickness) in a sectioned specimen identified by the writers as being identical with those studied by Stunkard and Maldonado. In a like manner, the esophagus was observed in *T. melospizae* by Penner (1939) and by Dollfus (1946) in *T. zarudnyi* (= *T. gallica*). The same observation is made by the present writers on specimens identified as *T. zarudnyi* and *Lepidopteria atra.*

The short, dilated portion of the esophagus described for members of the genus *Tanaisia* by Skrjabin (1924), and used as one of the main criteria for the separation of the genus *Tanaisia* from *Tamerlania* by Skrjabin and most subsequent observers, is not always the prominent feature as originally described. When the esophagus is visible in the whole mount it may or may not display such a dilation (Pl. I, Figs. 1 and 4). In observing the living worm the esophagus is clearly seen to change from an elongated tube in the extended worm to a short, dilated bulb-like condition in the contracted parasite, the degree to which the bulb-like dilation develops being dependent upon the amount of food material within the digestive tract. In contracting and extending the contents of the digestive tract can be observed to flow into and out of the esophageal portion, as well as to flow through the posterior fusion of the ceca.

In respect to the lobed condition of the testes in the genus *Tanaisia* as opposed to the rounded, smooth-bordered testes of *Tamerlania* the present writers find equally as much evidence of variations in these structures recorded in the literature and in the material at hand as was noted for the presence or absence of the esophagus. In general, the writers find that the testes of the entire group vary considerably within individuals from the same host animal, and as Stunkard (1945) stated in reference to the testes in *T. bragai* "They are . . . slightly lobed, and difficult to measure." Even when these bodies fail to show a more or less charactertistic vacuolated condition, which tends to distort the surface contour to the extent of giving the organs an indented appearance, the round, smooth-bordered gonad is seldom met with in natural infections: during the course of our study testes showing the round, smooth-bordered condition were encountered in a single specimen of *T. zarudnyi* from

the Parula Warbler and in a few specimens from the Alabama Towhee (Pl. III, Fig. 17). On the other hand, the testes in the fully matured forms from natural infections were found to vary in shape from round with even margins to highly irregular bodies with deeply indented (if not lobed) borders. It was not infrequent that the gonads displayed wart-like irregularities over their entire surfaces in both the *Tanaisia* and *Tamerlania* types. Thus, it is concluded that the inconsistency in the surface contour is one of the most constant features of the gonads in this group of trematodes. Such variations in form of the gonads, however, do not indicate generic differences, and hence this variation must be disregarded as a diagnostic character for the separation of the genus *Tamerlania* from *Tanaisia*.

A more constant feature of the testes is their location within the body. In those flukes which can be tentatively identified as belonging to the genus *Tanaisia* there is a greater variation noted for the level of the two testes in respect to each other than is true for these bodies in flukes tentatively identified as *Tamerlania*. The testes in the *Tamerlania* group vary from the opposite position to a slightly diagonal one. In no instance have the writers observed the testes in the *Tamerlania* group to be markedly diagonal (one testis entirely behind the level of the other) but it is not uncommon for one testis to lie caudally to the other by half of its diameter. In the *Tanaisia* group, on the other hand, the testes have been observed to occupy a position varying from slightly diagonal (Pl. I, Figs. 1 and 2) to the tandem position (Pl. I, Figs. 3, 4, 5, 6 and 7). There seems to be evidence which would indicate that the more tandem positions of the testes are the results of age of the parasite, and hence the development of senescence in the reproductive organs. Certainly it is observable that the more normal appearing testes occupy the less diagonal positions, while the smaller, more exhausted appearing testes occupy the more tandem positions. It is difficult to state the part played by the fixation of the parasite or the degree of contradiction and relaxation of the parasite at the time of fixation in the relative positions of the testes. It is to be pointed out, however, that all positions and conditions noted for the testes in this group of worms have been observed in similarly treated specimens from the same host species, and frequently from the same host animal. Such variations in the testes, both from the standpoint of outline and position, suggest to the writers that specific rather than generic characters are involved.

In the group of trematodes under study the ovary occupies a position to the right or left of the midline (more median in *T. atra*) near the junction of the first and second thirds of the body. In general, the contour of the ovary varies from round (a condition which the writers have not seen) to a deeply lobed body. When the testes are more nearly opposite (*Tamerlania*) the ovary is less likely to be deeply lobed (the ovary in the specimens from the Florida Blue Jay (Pl. II, Figs. 15 and 16) being the exceptions) than is true for the ovary when the testes are more diagonal or tandem in position. The lobed condition of the ovary, regardless of the position of the testes, is a highly variable feature and it is not infrequent that the ovary fails to show the open,

TABLE II.—The avian hosts and geographical distribution of *Tanaisia*[1].

Host species by orders and families	Species of *Tanaisia*	Locality	Authority
CICONIIFORMES			
(Threskiornithidae)			
Plegadis falcinellus (L.)	*atra*	Macedonia	Nezlobinsky, 1926
GALLIFORMES			
(Phasianidae)			
Phasianus chrysomelas bianchii Buturlin	*zarudnyi*	Togoul	Shtrom, 1935
Gallus gallus domesticus	*bragai*	Brazil	Santos, 1934
(Meleagrididae)			
Meleagris gallopavo domestica	*bragai*	Brazil	Barretto & Filho, 1942
GRUIFORMES			
(Rallidae)			
Rallus aquaticus L.	*fedtschenkoi*	Russia	Skrjabin, 1924
Fulica atra L.	*atra*	Macedonia	Nezlobinsky, 1926
Fulica americana americana Gmelin	*atra*	U.S.A.	Present paper
CHARADRIIFORMES			
(Charadriidae)			
Chettusia leucura (Lichtenstein)	*fedtschenkoi*	Turkestan	Skrjabin, 1924
Oxyechus vociferus vociferus L.	*fedtschenkoi*	U.S.A.	Present paper
(Scolopacidae)			
Capella delicata (Ord)	*fedtschenkoi*	U.S.A.	Present paper
Tringa nebularia (Gunner) (= *Totanus glottis* (Pallis))	*fedtschenkoi*	Turkestan	Skrjabin, 1924
Tringa (= *Totanus*) *ochropus* L.	*fedtschenkoi*	Russia	Skrjabin, 1924 Semenov, 1927
Tringa minuta (Leisler)	*fedtschenkoi*	Turkestan	Skrjabin, 1924
Pelidna alpina sakhalina (Vieil.)	*fedtschenkoi*	U.S.A.	Cheatum, 1938
(Recurvirostridae)			
Himantopus himantopus (L.) (= *H. candidus* Bonn.)	*fedtschenkoi*	Turkestan	Skrjabin, 1924 Shtrom, 1935
(Laridae)			
Larus canis L.	*fedtschenkoi*	Russia	Skrjabin, 1924 Semenov, 1927
Larus (= *Chroicocephalus*) *ridibundus* L.	*fedtschenkoi*	Russia	Skrjabin, 1924
Larus ridibundus sibiricus Buturlin	*fedtschenkoi*	Siberia	Issaitschikov, 1926
Sterna hirundo L. (= *S. fluviatilis* Naumann)	*fedtschenkoi*	Turkestan	Skrjabin, 1924
Sterna anglica Montagu	*fedtschenkoi*	Turkestan	Skrjabin, 1924
Chlidonias nigra (L.) (= *Hydochelidon nigra* (L.))	*fedtschenkoi*	Turkestan	Skrjabin, 1924
(= *Hydochelidon nigra* (L.))	*fedtschenkoi*	Macedonia	Nezlobinsky, 1926
COLUMBIFORMES			
(Columbidae)			
Columba livia Gmelin	*bragai*	Brazil	Santos, 1934
Columba domestica	*bragai*	Brazil	Reis & Nobrega, 1936

[1] Synonyms are not indicated in the table.

TABLE II.—(*Continued*)

Host species by orders and families	Species of *Tanaisia*	Locality	Authority
Columba domestica	*bragai*	Philippine Islands	Tubangui & Masilungan, 1941
Columba domestica	*bragai*	Puerto Rico	Maldonado & Hoffman, 1941; Maldonado, 1943; Stunkard, 1945; Maldonado, 1945
PICIFORMES			
(Picidae)			
Dendrocopus syriacus Hemprich	*zarudnyi*	Armenia	Khitrowo-Kalantarian, 1925; Skrjabin, 1927
PASSERIFORMES			
(Corvidae)			
Cyanocitta cristata florincola Coues	*zarudnyi*	U.S.A.	Present paper
Garrulus glandarius (L.)	*zarudnyi*	France	Dollfus, 1946
Garrulus glandarius japonicus Schlegel	*zarudnyi*	Japan	Yamaguti, 1941
Pica pica L.	*zarudnyi*	France	Dollfus, 1946
Pica pica hemileucoptera Stegm.	*zarudnyi*	Turkestan	Shtrom, 1940
Corvus corone L.	*zarudnyi*	France	Dollfus, 1946
Corvus cornix L.	*fedtschenkoi*	Russia	Shtrom, 1927; Ejsmont, 1932
Corvus cornix L.	*fedtschenkoi*	Germany	Korkhaus, 1930, '35; Noller, 1931
Corvus cornix L.	*fedtschenkoi*	Poland	Ejsmont, 1931, '32
Corvus frugilegus L.	*zarudnyi*	Crimea	Khitrowo-Kalantarian, 1925; Issaitschikov, 1927
Coloeus monedula (L.)	*zarudnyi*	Russia	Skrjabin & Massino, 1925; Khitrowo-Kalantarian, 1925
(Paridae)			
Panurus biarmicus (L.)	*fedtschenkoi*	Macedonia	Nezlobinsky, 1926
(Oriolidae)			
Oriolus kundoo Syk.	*zarudnyi*	Turkestan	Shtrom, 1940
(Turdidae)			
Turdus merula merula L.	*zarudnyi*	Macedonia	Nezlobinsky, 1926
Turdus merula merula L.	*zarudnyi*	Poland	Ejsmont, 1931, '32
Hylocichla guttata (Pallas)	*zarudnyi*	U.S.A.	Present paper
(Sylviidae)			
Hypolais sp.	*zarudnyi*	Turkestan	Shtrom, 1935
(Alaudidae)			
Ammomanes deserti subsp.	*zarudnyi*	Turkestan	Shtrom, 1940
(Motacillidae)			
Motacilla flava L.	*atra*	Macedonia	Nezlobinsky, 1926

TABLE II.—(*Continued*)

Host species by orders and families	Species of *Tanaisia*	Locality	Authority
(Muscicapidae)			
Muscicapa otricapilla (L.) (= *M. hypoleuca* (Pallas))	*zarudnyi*	Russia	Semenov, 1927
(Compsothlypidae)			
Compsothlypis americana americana (L).	*zarudnyi*	U.S.A.	Present paper
Seiurus aurocapillus (L.)	*bragai*	U.S.A.	Present paper
Limnothlypis swainsoni (Audubon)	*bragai*	U.S.A.	Present paper
(Sturnidae)			
Pastor roseus (L.)	*zarudnyi*	Turkestan	Shtrom, 1935
(Ploceidae)			
Passer montanus (L.)	*zarudnyi*	Turkestan	Skrjabin, 1924; Skrjabin & Massino, 1925; Khitrowo-Kalantarian, 1925; Semenov, 1927
Passer domesticus domesticus (L.)	*zarudnyi*	Brazil	de Almeida, 1935
(Icteridae)			
Euphagus carolinus (Muller)	*fedtschenkoi*	U.S.A.	Present paper
Quiscalus quiscula aeneus Ridgway	*bragai*	U.S.A.	Present paper
(Fringillidae)			
Fringilla coelebs L.	*zarudnyi*	Armenia	Khitrowo-Kalantarian, 1925
Montifringilla aipicola prosvirowi Zar.	*zarudnyi*	Turkestan	Skrjabin, 1927; Shtrom, 1940
Coccothraustes coccothraustes japonicus Temminck & Schlegel	*zarudnyi*	Japan	Yamaguti, 1935
Pipilo erythrophthalmus erythrophthalmus (L.)	*zarudnyi*	U.S.A.	Present paper
Pipilo erythrophthalmus canaster Howell	*zarudnyi*	U.S.A.	Present paper
Zonotrichia albicollis (Gmelin)	*zarudnyi*	U.S.A.	Present paper
Melospiza lincolni lincolni (Audubon)	*zarudnyi*	U.S.A.	Penner, 1939
Emberiza calandra L. (= *Miliaria europaea* Swainson)	*zarudnyi*	Turkestan	Shtrom, 1935
Emberiza variabilis Temminck	*zarudnyi*	Japan	Yamaguti, 1935

lobed condition when the testes occupy tandem levels within the body. The writers can find no evidence to support the separation of this group of flukes into two or more genera on the basis of the position and over-all contour of the ovary.

Table II gives the distribution of the trematodes under discussion from the standpoints of geographic locality from which they came, the order, family and species of bird host from which they were taken and the authority for the identification of the parasite.

From Table II it is seen that no less than seven orders, twenty-three families and fifty-eight species of birds have been reported as hosts for these

urinary tract inhabiting flukes. Although less than twenty of the reported host species are primarily New World forms, such varieties as the domestic chicken, turkey and pigeon, as well as the common English Sparrow, are practically cosmopolitan in distribution. The A.O.U. Check list of North American Birds, 1931 Edition, lists many of those Old World species, already reported as hosts of *Tanaisia*, as being accidental or regular visitors to the New World, and a few of them, such as the Ibis and Wagtails, have established local breeding areas in North America. On the other hand, many of the New World species are regular visitors to the Old World. Thus, the present writers are of the opinion that the geographical distribution of the individual species of bird hosts has played a minor role in the speciation of *Tanaisia*.

The separation of this group of flukes into two genera, *Tanaisia* and *Tamerlania*, by Skrjabin (1924) was based *in part* on the habitat of the host. The inadequacy of using this criterion for generic separation, perhaps, has become more obvious with the description of new species of parasites from a large number of additional bird hosts. Four of the orders of birds recorded in Table II are not necessarily associated with an aquatic habitat although most members of the other three orders are listed as preferring the aquatic or semi-aquatic habitat. Table II reveals the fact that in general the species *Tanaisia fedtschenkoi* is more often parasitic in the aquatic or semi-aquatic bird than is the case with the other species of the genus. In a like manner the species *T. zardunyi* and *T. bragai* appear to be more closely associated with the non-aquatic birds. A closer inspection of the contents of Table II shows that *T. atra* alone has been recorded from members of the order Ciconiiformes, that *T. zarudnyi* has been reported from a single species of woodpecker, order Piciformes, and that *T. fedtschenkoi* predominates as a parasite of the order Charadriiformes: *Tanaisia bragai* only is recorded from the order Columbiformes while *T. zarudnyi* is more often met with in the order Passeriformes. Both *T. zarudnyi* and *T. bragai* have been taken from the Galliformes and all four of the recognized species, *T. fedtschenkoi, T. zarudnyi, T. atra* and *T. bragai*, are recorded from the order Passeriformes. It would appear, therefore, that even the general distribution of these flukes among the families and orders of birds argues strongly in favor of their very close relationship. The general anatomical similarities between such forms as *T. fedtschenkoi*, a species more frequently associated with the aquatic or semi-aquatic host, and *T. zarudnyi*, represented by such a form as that recorded from the Florida Blue Jay (Table II, Figs. 15 and 16) would suggest a possible line of evolution within the group. The fact that *T. fedtschenkoi* is sometimes reported from passerine birds, families Corvidae, Paridae and Icteridae, tends further to substantiate this evolutionary trend. Regardless of such evolutionary suggestions, the differences to be found in the general anatomy of those flukes from aquatic bird hosts as contrasted with flukes from the non-aquatic hosts are specific in nature rather than generic. It is to be noted further that evidence from the life cycle of *T. bragai*, as recorded by Maldonado (1945), indicates the possibility of a terrestrial snail serving as the intermediate host, although the possi-

bility of an aquatic snail serving in this capacity has not been eliminated. The present investigators, therefore, do not accept the habitat of the vertebrate host as a criterion for the separation of these closely related flukes into several genera.

It was noted above that only four species are recognized for the genus *Tanaisia*, and that such a scheme of taxonomy was employed in Table II. The writers accept Ejsmont's (1931, 1932) pronouncement that the genus *Proshystera* Korkhaus, 1930, is a synonym of *Tanaisia*, and that the species *P. rossittensis* is identical with *T. fedtschenkoi*. They agree with Ejsmont (1932) also in considering *Tamerlania meruli* Nezlobinsky, 1926, to be identical with *T. zarudnyi*. In a like manner the writers agree with Yamaguti (1941) in believing *Tamerlania japonica* Yamaguti, 1935, to be identical with *T. zarudnyi*. Further, the present workers can find no reason for not accepting Dollfus' (1946) declaration of the synonymity of his newly created species, *T. gallica*, with *T. zarudnyi*.

The present investigators are in disagreement with most previous workers in the acceptance of *Tanaisia elliptica* Nezlobinsky, 1926, as a valid species. The identical arrangement and size of anatomical parts with those of *T. fedtschenkoi*, together with identical bird host, *Chlidonias* (= *Hydrochelidon*) *nigra* (L.), from the same general geographical locality, argue strongly in favor of synonymity. The only point of difference between the two forms is the unobserved union of the ceca in *T. elliptica*. It will be recalled that Skrjabin completely overlooked the union of the ceca in his study of the original material: no mention is made of the fusion of the ceca in the original diagnosis of *Tanaisia*. In the writers opinion, therefore, *T. elliptica* must be considered a synonym of *T. fedtschenkoi*.

In the same paper Nezlobinsky (1926) created two new genera, *Ohridia* and *Lepidopteria*, and assigned them to the family Eucotylidae. In the former genus Nezlobinsky placed his newly created species, *O. panuri*, a species described as having diagonally placed, smooth bordered testes. Three new species were described by Nezlobinsky and placed in the genus *Lepidopteria*, *L. atra*, *L. plegadis* and *L. graciosa*. In considering these genera and species it is the immediate impression that the presence or absence of the esophagus, the general outline and position of the gonads and the general habitat of the avian host were the deciding factors in the erection of these genera and in the establishment of the four species. The general morphology of the species described by Nezlobinsky do not differ sufficiently from already described species to warrant the emphasis he gave to certain of the more minor characters of the group. Due to the marked diagonal position of the testes in *O. panuri* it is the writers' belief that this species readily falls within the range of variation noted for *T. fedtschenkoi* and, therefore, must be considered a synonym of that species. The differences noted for the shape of the ovary in the three species assigned to the genus *Lepidopteria*, on the other hand, represent a variation in anatomical details which is specific rather than generic in value, especially in the absence of other major differences. Even here the variations in the ovary of the three species undoubtedly represent modifications which can not be taken

to be of specific value. Thus, the writers are of the opinion that the three species, as created by Nezlobinsky, are varieties of the same organism, and that the genus *Lepidopteria* is a synonym of *Tanaisia*. On the basis of page priority the correct designation for the species is *Tanaisia atra* (Nezlobinsky, 1926).

Two species of urinary tracts inhabiting flukes of the type under discussion have been described from birds from the United States. The first of these, *Tanaisia pelidnae*, was described by Cheatum (1938), who separated it from *T. fedtschenkoi* primarily on the basis of the tandem position of the testes. In view of the fact that this variation readily falls within the range described for *T. fedtschenkoi*, the writers must conclude that the two species are identical. The second species, *Tamerlania melospizae*, was described by Penner (1939). Since only a single specimen was available for study the extent of variations known to occur in already described species could not have been observed. Further, those differences which were noted and which seemed to distinguish the specimen from already known species are now known to be normal variations for *T. zarudnyi*. Thus, *T. melospizae* must become a synonym of *T. zarudnyi*.

In the present state of knowledge it is impossible to accurately determine affinities for the genus *Tanaisia*. The authors, however, are not in agreement with Skrjabin (1924) in considering the genera *Eucotyle* Cohn, 1904, and *Tanaisia* Skrjabin, 1924, assignable to the same family (Eucotylidae) group. Although most subsequent workers have accepted Skrjabin's classification of the group, the arrangement, in the light of more recent studies, seems to be a most unnatural one, based entirely upon superficial resemblances of the adult worms and similarities of habitat within the host animal. In this connection it might be pointed out that little or nothing is known beyond the more obvious anatomical details concerning members of the genus *Eucotyle*. In reference to those details of the anatomy which are known the transverse, dorsoventral muscular collar which rather completely separates the body into the pre- and post-collar portions, the absence of the acetabulum and the failure of the ceca to unite in the posterior portion of the body seem to preclude any close association of these forms with the members of the genus *Tanaisia*. Such striking differences between members of the two genera greatly outweigh a similarity of habitat and the same relative positions of the gonads. In so far as it is known nothing concerning the developmental cycle of *Eucotyle* has been made known nor has any reference relative to the type of excretory system possessed by members of the genus come to our attention. Until such a time when information covering these two vital points is available the writers must consider the genus *Eucotyle* as one of the unclassified genera of the Monostomata.

Through the investigations of more recent workers (Stunkard, 1945, Maldonado, 1945, and Dollfus, 1946) considerable details relative to anatomical parts of certain members of the genus *Tanaisia* have been made known, and Maldonado (1945) has given certain information covering the developmental cycle of *T. bragai* (Santos, 1934). Knowledge concerning the developmental

cycle of this species is as yet incomplete although the essential facts as presented by Maldonado would indicate that the form bears no resemblance to any known monostomate trematode about which similar facts are known. The ova of *T. bragai* are fully embryonated when oviposited. The ciliated miracidium fails to hatch until after it is ingested by the terrestrial snail *Subulina octona*. Once inside the snail the miracidium metamorphoses into a small, sluggish mother sporocyst which gives rise to daughter sporocysts within ten to twelve days. The daughter sporocyst is a passive structure which gives rise to from one to ten tailless, delicate cercariae. The cercaria is mature within about four weeks and encysts within the cavity of the daughter sporocyst. The encysted metacercaria reaches the final host when the parasitized snail is ingested. It excysts in the upper part of the intestine and migrates down to the cloaca, thence up the ureter where it matures. Ova are present in the uterus of the young adult worm within about twelve days after it gains access to the definitive host.

The absence of the ventral sucker, as has been shown by many workers in the field of helminthology, does not constitute a valid basis for assigning the sexually mature trematode to the order Monostomata. In the light of our present knowledge the actual existence of a well founded order of monostomate trematodes is questionable. Almost daily, trematodes of good standing in yesterday's order Monostomata are being shown to be distomes with degenerated ventral suckers or monostomate forms which are developing distomate characteristics. In general, trematodes which fail to show a ventral sucker in one or another of its developmental stages develop from one or more redial generations. In this respect the recent report on the life cycle of *T. bragai* by Maldonado (1945) in which the larval stages develop in sporocysts, together with the fact that all immature specimens possess the ventral sucker and the cercariae are tailless, renders the assignment of these flukes to the order Monostomata invalid. The development of the soft-bodied, non-muscular, tailless cercaria of *T. bragai* in passive, ovoid or spherical, sacculated sporocyst in which it encysts to await transfer to the definitive host suggests a closer relationship of the group to the Dicrocoelioidea Faust, 1929, than to any known monostomate form. In so far as it has been worked out the type of excretory system displayed by the genus *Tanaisia* precludes too close an association with this superfamily, however, certain features of the system in *T. bragai*, as observed by Maldonado (1945), Stunkard (1945), Dollfus (1946) and by the writers, place these forms not too far removed from the Dicrocoelioidea. The two systems are at variance primarily in respects to the behavior of the anterior main collecting tubule. Maldonado (1945) describes the system as follows: "The excretory system is clearly visible. The bladder is thin, undulating, and opens ventrad. It extends to the level of the acetabulum where it bifurcates at right angles into two main trunks each of which in turn subdivides into an anterior and a posterior secondary duct. The former is convoluted and extends forward turning back on itself at the level of the oral sucker to end in the vicinity of the acetabulum. The latter is undulated and ends at the posterior end of the body. The flame cells are forty in number, arranged in pairs on

the sides of the body. Their relative position varies but in general eight pairs are located preacetabulad and the other postacetabulad." The union of the capillary tubules of the flame cells with the secondary ducts was not observed, hence the exact nature of their union can not be stated. The turning back of the anterior main collecting tubule on itself to end in the vicinity of the acetabulum is not readily compatible with the Dicrocoelioidea type of system, although the general organization of the system in *Tanaisia*, together with the developmental cycle of the form, suggests a realtionship here that is not too far removed.

KEY FOR THE SEPARATION OF THE RECOGNIZED SPECIES OF THE GENUS TANAISIA

1. Testes opposite or only slightly oblique in position; usually irregular in shape but without a definite lobation 2

   Testes from diagonal to tandem in position; usually irregular in shape, often strongly lobed 3

2. Vitellaria in central third of body, commencing near level of gonads and extending well beyond testes ..... *T. zarudnyi* (Skrjabin, 1924)

   Vitellaria more extensive, beginning in advance of ovary and extending beyond level of testes ..... *T. bragai* (Santos, 1934)

3. Ovary median in position, more or less H- or butterfly-shaped ..... *T. atra* (Nezlolobinsky, 1926)

   Ovary more lateral in position, often with deep, dendritic-like lobation ..... *T. fedtschenkoi* Skrjabin, 1924

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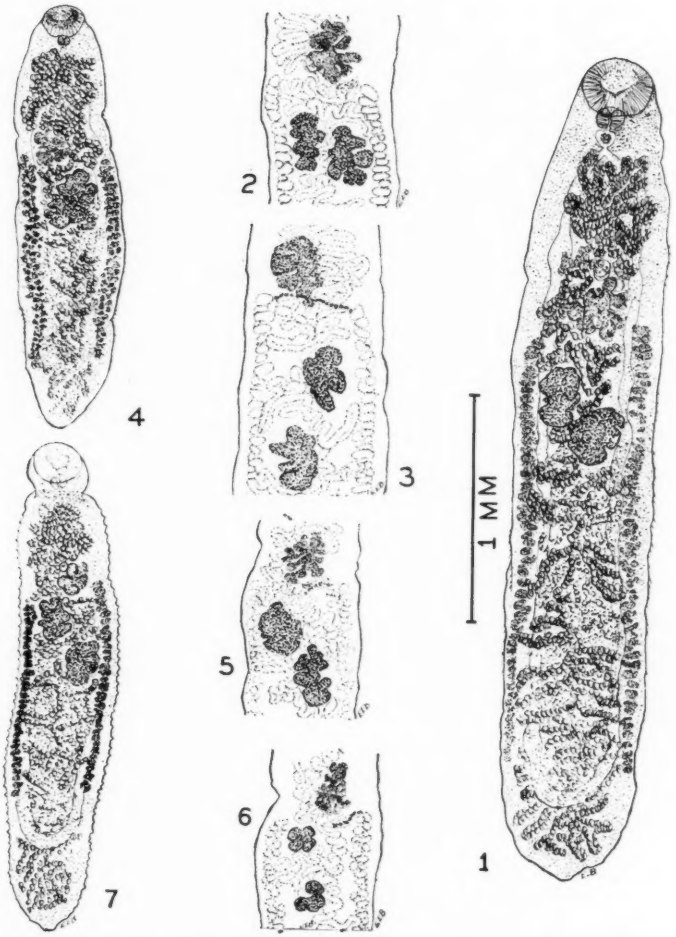
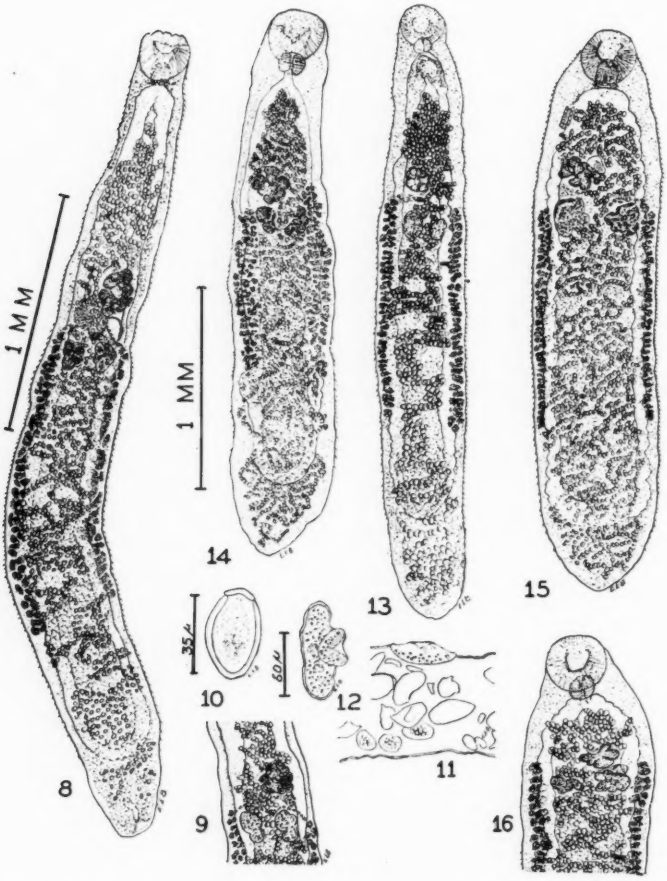
PLATE I



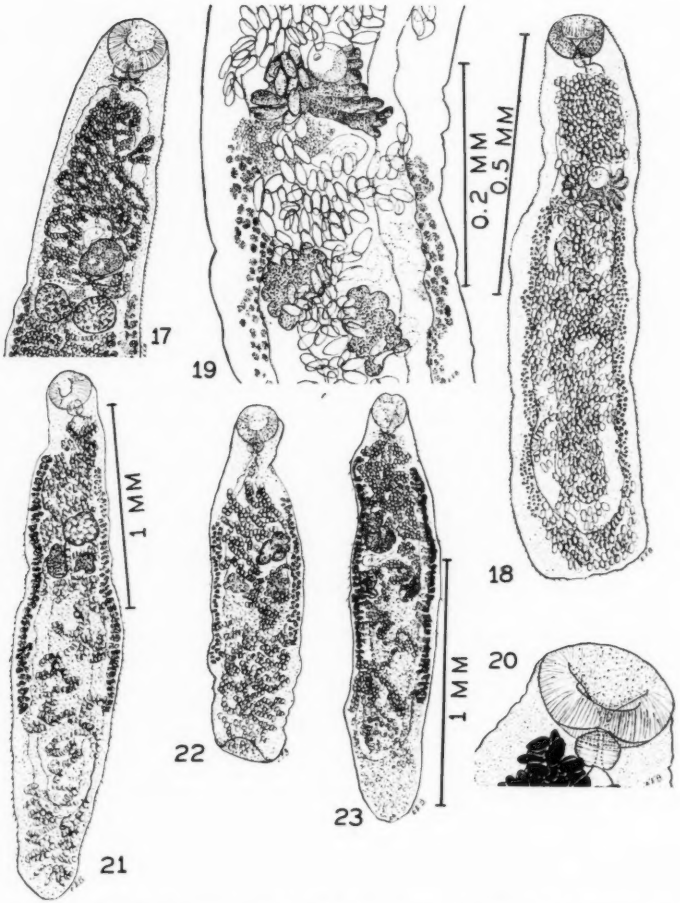
Figs. 1-7. *Tanisia fedtschenkoi* Skrjabin, 1924.—1. Mature specimen from ureter of Killdeer, *Oxyechus vociferus vociferus* (L.); 2. Portion of another specimen showing the diagonal position of the testes; 3. Portion of another specimen showing tandem position of testes; 4. Mature specimen from ureter of Wilson's Snipe, *Capella delicata* (Ord); 5. Portion of another specimen showing overlapping levels of the testes; 6. Portion of another specimen showing tandem position of the testes; 7. Mature specimen from ureter of Rusty Blackbird, *Euphagus carolinus* (Muller). (Camera lucida: unless otherwise indicated, all figures are drawn to the same scale.)

PLATE II



Figs. 8-16. *Tanaisia zarudnyi* (Skrjabin, 1924), nov. comb.—8. Mature specimen from ureter of Red-eyed Towhee, *Pipilo erythrophthalmus erythrophthalmus* (L.); 9. Portion of another specimen from the same host; 10. Mature egg from specimen from Red-eyed Towhee; 11. Cross section through ventral sucker of specimen from Red-eyed Towhee; 12. Cross section through ventral sucker of immature specimen from the Red-eyed Towhee; 13. Mature specimen from ureter of White-throated Sparrow, *Zonotrichia albicollis* (Gmelin); 14. Mature specimen from ureter of Hermit Thrush, *Hylocichla guttata* (Pallas); 15. Mature specimen from ureter of Florida Blue Jay, *Cyanocitta cristata florincola* Coues; 16. Anterior half of another specimen from the Florida Blue Jay. (Figures 9, 11, 13, 14, 15 and 16 drawn to the same scale: Camera lucida.)

PLATE III



Figs. 17-23.—17. *Tanaisia zarudnyi* (Skrjabin, 1924). Anterior half of mature specimen from ureter of Southern Parula Warbler, *Compsothlypis americana americana* (L.), showing smooth borders of gonads; 18. *Tanaisia atra* (Nezlobinsky, 1926), nov. comb. Mature specimen from ureter of American Coot, *Fulica americana americana* Gmelin; 19. Portion of another specimen from the same host, showing the location of the gonads; 20. Anterior portion of same specimen as Fig. 19, showing details of the oral sucker; 21. *Tanaisia bragai* (Santos, 1934), nov. comb. Mature specimen from ureter of Bronzed Grackle, *Quiscalus quiscula aeneus* Ridgway; 22. Mature specimen of same species from ureter of Swainson's Warbler, *Limnothlypis swainsoni* (Audubon); 23. Mature specimen of same species from ureter of Oven-bird, *Seiurus aurocapillus* (L.). (Camera lucida: Figures 17, 21 and 22 are drawn to the same scale.)

Platyhelminths from Fur Bearers in the Wichita Mountains Wildlife Refuge, with Especial Reference to Oochoristica spp.

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In 1943, Mr. Frank B. McMurry, Biologist at the Wichita Mountains Wildlife Refuge, Cache, Oklahoma, deposited in the Museum of Zoology, University of Oklahoma, a large collection of parasites from the wildlife of that refuge. Since Mr. McMurry made the collection incidental to other studies, he kindly offered it to the senior author for study purposes. It includes the Platyhelminths from 17 feral house cats (*Felis domestica* Brisson), 3 spotted skunks (*Spilogale interrupta* Raf.) 34 striped skunks (*Mephitis varians* Gray), 15 opossums (*Didelphys virginiana* Kerr), 69 coyotes (*Canis latrans* Say), and one raccoon (*Procyon lotor* (L.)).

The data presented here give no conclusive evidence as to the rate of infection in the total populations since only records of infected animals are available. Although the hosts studied were not confined to the refuge area, it is unlikely that they roamed extensively outside its limits. It is felt, therefore, that a study of this type gives as true a picture as it is possible to obtain of the natural parasitic fauna of the hosts in this southwestern area.

Materials and Methods

All of the parasites studied were fixed in 70% alcohol. Most of them were fresh when fixed but some were removed from animals that had been killed by accident and had been dead for some hours before autopsy. For this reason, not all were in a good state of fixation and were difficult to stain. When deposited in the Museum of Zoology in 1943, all specimens were placed in 70% alcohol with 2% glycerine added. Specimens were stained with either Ehrlich's acid hematoxylin, Delafield's hematoxylin, Mayer's paracarmine, or a mixture of Ehrlich's and Delafield's hematoxylin.

Observations

Feral house cat.—In the 17 hosts studied, *Taenia taeniaeformis* Batsch was the most common parasite. One host collection was too poorly preserved for identification, but all others except one contained this tapeworm. There was an average of 10.4 specimens per host and one harbored 46. *Dipylidium canimum* Lin. was present in two hosts. One harbored 8 specimens and no other tapes while another harbored 11 specimens and 1 of *T. taeniaeformis*. *Mesocestoides variabilis* Mueller occurred in one host which also harbored 2 *T. taeniaeformis*.

Coyote.—In the 69 coyote collections studied only *Taenia pisiformis* Gmelin was found. All were infected with this tape, the number of worms in any one host varying from 1 to 253. The largest number of adult worms found in one host was 127. The average number was 12. Many juvenile cestodes were included in the total counts and, of course, their specific identification is not certain in all cases. Since all adults are *T. pisiformis*, it seems reasonable to assume that most of the juveniles belong to that species.

The fact that *Echinococcus granulosus* Rudolphi does not occur in this collection is not taken to mean that it is absent in the coyotes of the region. Since the collector was not primarily interested in parasites, he could have overlooked this small cestode.

Opossum.—One of the 15 collections from *Didelphys* contained a fragmentary strobila of a cestode. It was so poorly preserved, however, that classification was impossible. One host was infected by the trematode *Rhopalias macracanthus* Chandler. This is the first report of this fluke from *Didelphys* in Oklahoma..

Raccoon.—The one collection from a raccoon contained 35 specimens of *Mesocestoides latus* Mueller. Insofar as the authors know, this species has not been previously reported from the raccoon.

Spotted skunk.—In the three collections examined from the spotted skunk, one included 5 fragments of *Mesocestoides variabilis* Mueller, another contained 1 strobila of the same species and the third contained 1 incomplete strobila of a tapeworm too poorly preserved for identification.

Striped skunk.—Of the 57 collections from the striped skunk, 11 contained *Mesocestoides latus*. The number per host ranged from 2 to 200 with an average of 71 per infected host.

Six of these hosts were also infected with a cestode belonging to the genus *Oöchoristica* Lühe. The number per host varied from 8 to 100 with an average of 35.0. These tapeworms closely resemble both *O. mephitis* Skinker and *O. oklahomensis* Perry, and it has been difficult to determine the species. The important taxonomic characters of these two species are tabulated in table 1, from which it can be seen that the present specimens are as closely related to one as the other. One could hardly consider the over-all size relations of significant value in determining species in this case although it is interesting that our specimens are shorter but have a greater number of proglottids than in the other specimens. The diameter of the scolex increases progressively from *O. mephitis* to our specimens with an overlapping between *O. mephitis* and *oklahomensis*. The same is true of the diameter of the suckers. The cirrus pouch of *O. mephitis* and in our specimens extends to the excretory duct whereas it does not in *O. oklahomensis*. An examination of Perry's specimens, however, indicates that this difference could well be due to fixation. The number of testes is the same in *O. oklahomensis* and in our specimens and overlaps the minimum number listed for *O. mephitis*. The size of the eggs in our specimens overlaps that of both species although the latter do not overlap each other. The relation of the genital pore to the excretory duct is the same in

all three. The location and diameter of the genital atrium are essentially the same for *O. oklahomensis* and our specimens. No data on these two characters are available for *O. mephitis*. The diameter of the testes is essentially the same as that in *O. mephitis* and less than that given for *O. oklahomensis*. The diameter of the shell gland is largest in *O. mephitis* and smallest in our specimens.

From the above data, it would be impossible to place the specimens considered here in either *O. mephitis* or *O. oklahomensis*. It seems that our specimens merely establish a wider variation in *O. mephitis* than previously

TABLE 1.—Comparative data on *Oöcharistica* species.

	O. mephitis	O. oklahomensis	McMurry Specimens
Length of strobila	11-25 mm	29-124 mm	64-71 mm
Width of strobila	1.3 mm	0.9-1.47 mm	0.85-2.3 mm
Diameter of scolex	429-689 μ	508-705 μ	850 μ
Diameter of suckers	159-260 μ	222-225 μ	340 μ
Cirrus Pouch	55-65 μ	Never reaches excretory vessel	Extends to excretory duct
Extent of cirrus pouch	To lateral excretory duct	Never reaches lateral excretory vessel	To lateral excretory duct
Testes—no. and Arrangement	44-75. Posterior and lateral to ovary. Greater No. in aporal half of segment.	37-46. Posterior and lateral to ovary. Greater No. in aporal half of segment.	37-46. Posterior and lateral to ovary. Greater No. in aporal half of segment.
Seminal Receptacle	Present	Present	Present
Diameter of eggs	30 μ	36-47 μ	25-59 μ
Relation of gen. pore to excretory duct	Dorsal	Dorsal. Ventral to nerve.	Dorsal
No. of proglottids	70	40-70	90-140
Location of gen. papillae	.....	First 1/3 of segment in mature proglottid. Middle of immature proglottid.	Anterior 1/3 of segment and in middle of immature proglottid.
Diameter of genital atrium	.....	35-40 μ	34-42.3 x 34 μ
Diameter of testes	40 μ	70-94 μ	42-51 μ
Diameter of shell gland	40 μ	36 μ	34 μ
No. of gravid proglottids	7-23	From 110th to 120th proglottid.	Up to 10

shown and in this case *O. oklahomensis* becomes synonymous with *O. mephitis*.. Specimens in this collection are, therefore, placed in the species *mephitis* because of priority.

SUMMARY

The platyhelminths of 17 feral house cats, 3 spotted skunks, 34 striped skunks, 15 opossums, and 69 coyotes collected in the Wichita Mountains Wildlife Refuge are reported.

The feral house cats harbored *Taenia taeniaeformis, Dipylidium caninum* and *Mesocestoides latus*. Only *Taenia pisiformis* was recovered from the coyotes. From the opossums a fragmentary cestode which was not identifiable and the trematode *Rhopalias macrocanthus* were recovered. *Mesocestoides variabilis* was taken from the spotted skunk and *Mesocestoides latus* and *Oöchoristica mephitis* from the striped skunk.

Rhopalias macrocanthus is reported from Oklahoma opossum for the first time, and *M. latus* is reported from the raccoon for the first time.

Specimens of *Oöchoristica* from *Mephitis varians* check closely with descriptions of both *O. mephitis* and *O. oklahomensis* and are placed in the former species because of priority.

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Studies on Bovine Gastro-intestinal Parasites XV. The Length of Life of the Adult Nodular Worm and Hook Worm in the Calf.

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In the course of our experiments with nematode parasites of cattle, we have had the opportunity to keep a few animals for considerable periods of time under controlled conditions of parasitic infection. Most of these animals have been kept for a source of eggs of pure infections from which to culture larvae for inoculations. Since records of longevity of adult parasites, particularly those of larger animals, are not numerous it seems desirable to report these data briefly. In an earlier paper (Mayhew 1942), we reported that the adult *Haemonchus contortus* can live at least 14½ months, there being a gradual decrease in the egg counts suggesting a slow decrease in the worm population. For the sake of brevity, we include only one other reference (Sandground 1936) which gives a summary of records of longevity of a number of species of parasites.

Methods

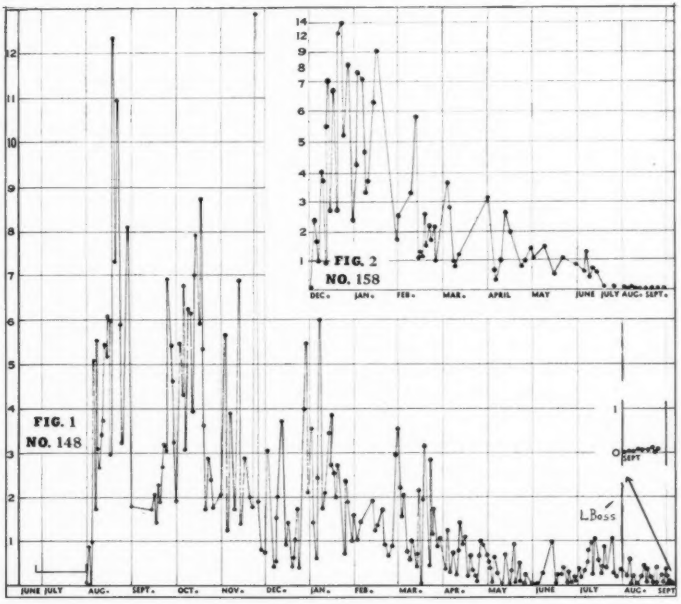
The animals reported on in this paper were obtained when but a few hours old and placed in individual cages in the animal building of the Veterinary Science Department. The rooms have concrete floors and the cages, wire floors supported 15 inches above the room floors. The cages and rooms were cleaned and washed twice a week. The calves were fed milk prepared in a sanitary manner and water from the city water supply. The hay was cut from land that had not been grazed by cattle and the same brand of commercial grain concentrate was fed throughout the experiments. This system of management has prevented the introduction of infection from the outside and prevented the spread of infections set up by inoculations within the building over a period of 12 years.

Experimental Results

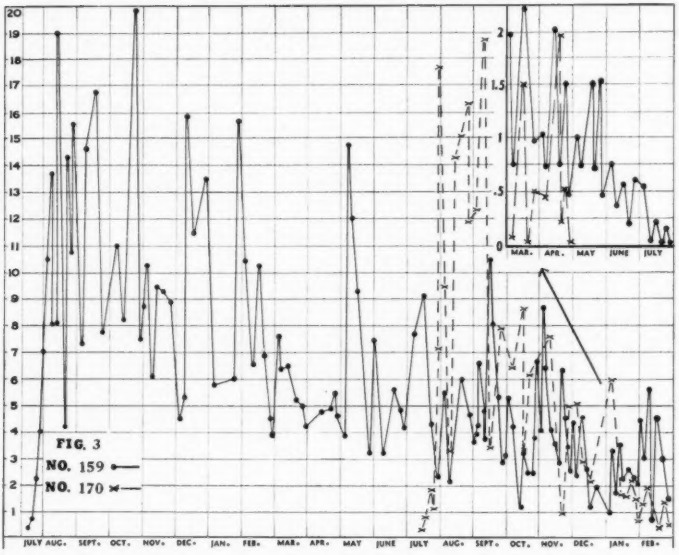
Calf No. 148.—This animal was a pure bred Holstein male born March 1, 1944. On June 24, 1944 he was given a small number of infective nodular worm larvae cultured from eggs obtained from adult nodular worms recovered from calves killed at the Baton Rouge City Abbatoir. The first eggs were recovered from the feces on July 31, 1944. It will be noted that the egg count increased during August to a maximum of a little over 12 eggs per gram of sediment (fig. 1) and that there followed a gradual decrease in the number of eggs until the end of the period of observation in September, 14 months

after the appearance of the first eggs. He was reinoculated with a very small number of nodular worm larvae on May 26, 30, July 15, and 27, 1945. But, it will be noted, there was no essential change in the egg counts. From these data it is evident that the adults of the nodular worm live at least 11 months and possibly 14 months.

Calf No. 158.—This animal was a pure bred Holstein male born September 29, 1945. Typical hookworm eggs were recovered from the feces on November 28, 1945, 60 days after birth. We believe that this is quite clearly an instance where the calf secured the infective larvae during the few hours between birth and removal to the experimental cages since the time interval agrees with the prepatent period in our experimental inoculations, and since our methods of care have prevented the spread of infections within the building in 178 animals over a period of 12 years. It will be noted that the egg count increased to a maximum of 14 eggs per gram of sediment in about 3 weeks (fig. 2) then gradually decreased until August 14, after which time examinations were entirely negative and remained negative even though the animal was reinoculated several times over a period of 6 months in an attempt to make further use of him in the experiments. It is evident from the observations on this calf that the adult hook worms may live as long as 8½ months.



Figs. 1, 2.—Egg production by parasites harbored by calves nos. 148 and 158.



Figs. 3, 4.—Egg production by hookworms harbored by calves nos. 159 and 170.

Calf No. 159.—This animal was a pure bred Holstein male born on October 11, 1945. Infective hookworm larvae cultured from a calf with a pure infection of hookworms were placed on his flank on May 26, 1946. The first hookworm eggs appeared in the feces on July 22, 1946 after 40 negative fecal examinations made during the preceding 8½ months. It will be noted (fig. 3) that the maximum counts obtained were slightly under 20 eggs per gram of sediment, from which point they gradually decreased to the end of the period of observation 24 months later when the calf was killed on August 20, 1948. Since August 1st, 8 out of the 16 fecal examinations were negative and the others contained but 1 to 3 usually abnormal eggs. At the postmortem examination 3 female hookworms were recovered from the fourth stomach and 4 females from the anterior portion of the small intestine. No other parasites were recovered and all of the parasite eggs observed during the total of 334 positive fecal examinations made on this animal were typical hookworm eggs. We do not believe that any reinfection occurred in the case of this calf since from 5 to 10 other animals were kept under the same conditions of management at all times during the experiment. These observations indicate that adult hookworms may live as long as two years in the calf.

Calf No. 170.—This animal was a pure bred Holstein male born May 21, 1947. On May 23, hookworm larvae cultured from No. 159 were placed on the skin of the right side of this animal. The first eggs were recovered from

the feces on July 15. Fecal examinations made once a week during the preceding 5 weeks were all negative. It will be noted (fig. 3) that the egg counts reached their maximum during the following 7 weeks then gradually declined to a very low level toward the end of the period of observation, 9½ months after the first positive fecal examinations. Daily count between April 15 and 26 varied between 0.03 and 0.93 eggs per gram of sediment. A total of 87 positive fecal examniations were made during the period of the experiment. Because of lack of space only selected counts, chiefly maximum and minimum, are shown in figure 3.

SUMMARY

Data are presented on the length of life of adult nodular worms (*Oesophagostomum radiatum*) in one calf and of adult hookworms (*Bunostomum phlebotomum*) in three calves kept under conditions of controlled parasitic infection.

The adults of the nodular worm can live at least 11 months and possibly as long as 14 months. The adult hookworms have lived as long as 8½, 9½, and 24 months in the calves observed.

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The Dragonflies of Mississippi (Odonata: Anisoptera)

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Dragonfly adults and nymphs were collected by the author at approximately weekly intervals in the general vicinity of Oxford, Lafayette County, from June 1, 1947 to February 1, 1948. During this period it became obvious that an interesting assortment of species was present in the area. Subsequently efforts to locate all previous State records showed that Mississippi is an almost total blank in our knowledge of dragonfly distribution. No comprehensive State list has been published. A few definite records were found in the following: Needham (1942), Borror (1942), Westfall (1943), Wright (1937, 1939, 1943). These workers give specific records for but six species: *Gomphus modestus, Gomphus potulentus, Erythrodiplax berenice, Erythrodiplax connata minuscula, Libellula auripennis, Libellula needhami, Macrodiplax balteata.*

Attempts to locate specimens in local institutions revealed that the only collection was that of Mississippi State College. This was made available for study through the courtesy of Dr. Clay Lyle of that institution.

Additional records of Mississippi material in the University of Michigan, Museum of Zoology, the Illinois Natural History Survey and in the collection of Mrs. L. K. Gloyd were obtained through the courtesy of Mrs. Gloyd. Material in these institutions was not examined. Likewise specimens collected by Mr. John McLure were not examined by the author but were determined by Mrs. Gloyd. Collections of Mr. M. C. Kemp and of Mr. V. W. Cole, students at the University of Mississippi, were examined but the majority of the specimens have been retained by them.

Records from these sources plus subsequent collections in the southern part of the State make possible a reasonably complete check list of the dragonflies of Mississippi.

The style for the individual record is as follows: the specific locality; the number of individuals, stage in life cycle and if adult the number of each sex; the collector; the date; the present location of the specimen in italics. When italics are not included in the record the collection was retained by the collector.

Abbreviations of institutions housing Mississippi specimens and of the collectors are:

ALD—Mrs. Alice L. Dietrich
CLB—C. L. Brinson
CRB—C. R. Ball
CU—Cornell University
FHL—F. H. Lowe
MSC—Mississippi State College (Mississippi A and M)
MCK—M. C. Kemp

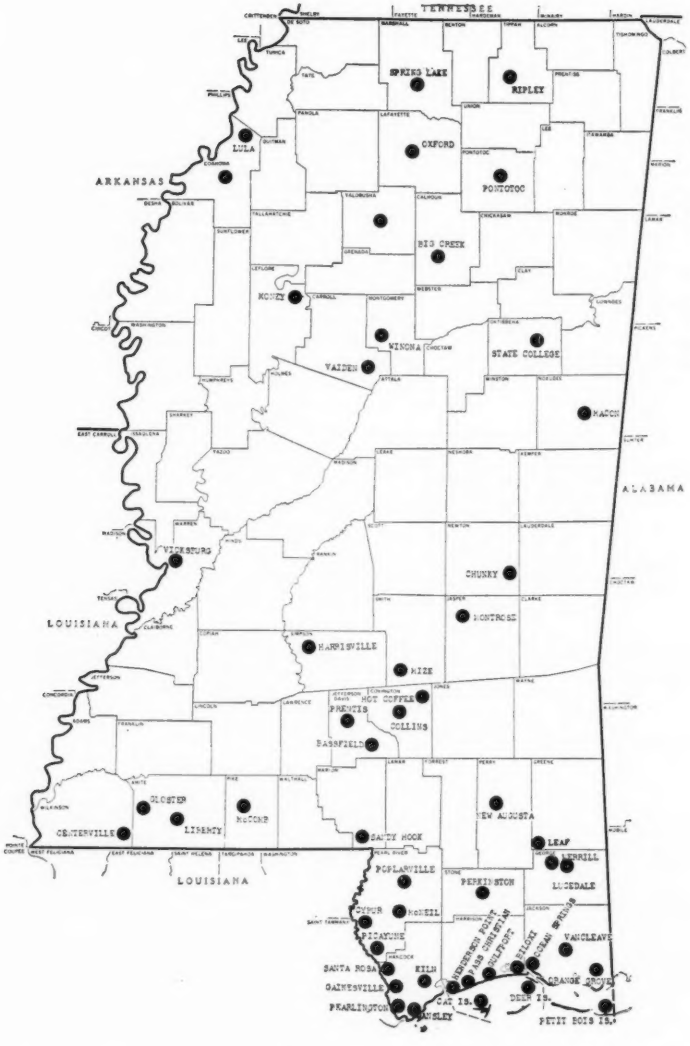

Fig. 1.—Localities from which dragonflies have been recorded. Unlabelled dots are county records without specific localities.

MMK—M. M. Kraus
GHB—G. H. Bick
GHP—G. H. Penn
INHS—Illinois Natural History Survey
LKG—L. K. Gloyd collection
SAG—S. A. Gardner
TU—Tulane University
UM—University of Michigan
VWC—V. W. Cole

Thirty-one of the State's 82 counties are represented in the collections. Figure 1 shows localities of all records to date. Much more widespread collecting is needed in order to obtain a thorough State survey. It is hoped that this work may serve as a stimulus for additional collecting from areas which are not represented as yet. Especially desirable would be collections from the Mississippi river counties, and from the central part of the State.

Some idea of the thoroughness of collecting in the 31 counties represented may be obtained by listing the number of species recorded from each:

No. of Species	County	No. of Species	County
24	Oktibbeha	6	Amite, Montgomery
21	Lafayette	4	Wilkinson
17	Hancock	3	Jasper, Pike
14	Harrison	2	Marion, Smith, Warren, Yalobusha
13	Coahoma		
11	Marshall, Pearl River	1	Carroll, Calhoun, Greene, Leflore, Newton, Noxubee, Perry, Pontotoc, Simpson, Stone, Tippah
9	Jefferson Davis		
8	Covington		
7	George, Jackson		

PROGOMPHUS OBSCURUS (Rambur)

AMITE CO.—Gloster: 3 nymphs, GHP, 7/4/48, *TU* 581. JEFFERSON DAVIS CO.—Bassfield: 3 nymphs, F. Cagle 4/17/48, *TU* 301; 1 nymph, F. Cagle, 4/17/48, *TU* 200. LAFAYETTE CO.—Oxford: 1 cast skin, GHB, 7/13/47, *TU* 315; 1 male, VWC, July, 1947. NOXUBEE CO.—Macon: 5 nymphs, GHP, 6/22/47, *TU* 65.

The species is represented by five collections of nymphs. All were from sandy, flowing creeks.

DROMOGOMPHUS SPINOSUS (Selys)

AMITE CO.—Gloster: 1 nymph, GHP, 7/4/48, *TU* 581. Liberty: 3 nymphs, GHP, 7/4/48, TU 583. COVINGTON CO.—Prentiss 9 miles east: 1 nymph, CLB, 6/19/48, *TU* 393. Hot Coffee: 1 nymph, CLB, 6/19/48, *TU* 609. JEFFERSON DAVIS CO.—Prentiss 3 miles northwest: 2 nymphs, CLB, 7/10/48, *TU* 622. LAFAYETTE CO.—Oxford: 1 nymph, GHB, 7/26/47, *TU* 319; 1 nymph, GHB, 8/16/47, *TU* 329; 1 nymph, GHB, 8/17/47, *TU* 330; 1 nymph, GHB, 10/18/47, *TU* 340; 1 nymph, GHB, 11/28/47, *TU* 351; 3 nymphs, GHB, 11/28/47, *TU* 325. MARSHALL CO.—Spring Lake: 1 nymph, GHB, 11/9/47, *TU* 348; 1 nymph, GHB, 9/28/47, *TU* 332. PIKE CO.—McComb: 3 nymphs, GHP, 7/5/48, *TU* 586.

Represented by 14 collections of nymphs. Eight were from sandy flowing creeks, six from static mud bottom ponds.

GOMPHUS MODESTUS Needham

GEORGE CO.—Lucedale: 1 male, ALD, 4/25/29, *CU*, (Needham, 1942).

The female and nymph are undescribed.

GOMPHUS POTULENTUS Needham

GREENE CO.—Leaf: 1 male, ALD, 7/5/31, *CU*, (Needham, 1942).

The female and nymph are undescribed.

GOMPHUS FLAVOCAUDATUS Walker

OKTIBBEHA CO.—State College: 1 male, A. P. Fatheree, 4/15/25, *MSC*; 1 male, H. H. Martin, 4/4/36, *MSC*; 1 adult, abdomen missing, C. N. Godbold, 4/17/36, *MSC*.

The female and nymph are undescribed.

BOYERIA VINOSA (Say)

AMITE CO.—Gloster: 2 nymphs, GHP, 7/4/48, *TU* 581. COVINGTON CO.—Collins 9 miles west: 1 nymph, CLB, 7/3/48, *TU* 610. JEFFERSON DAVIS CO.—Prentiss: 6 nymphs, CLB, 7/3/48, *TU* 391; 4 nymphs, CLB, 7/3/48, *TU* 611. LAFAYETTE CO.—Oxford: 1 nymph, GHB, 7/13/47, *TU* 313; 1 nymph, GHB, 8/9/47, *TU* 325; 2 nymphs, GHB, 8/17/47, *TU* 330; 19 nymphs, GHB, 10/4/47, *TU* 334; 3 nymphs, GHB, 10/18/47, *TU* 340; 1 male, MCK, 7/17/47. MARION CO.—Sandy Hook: 6 nymphs, GHP, 8/11/48, *TU* 755. WARREN CO.—Vicksburg: 1 male, GD, without date, *INHS*, (data from L. K. Gloyd).

Nine of the ten collections of nymphs were from sandy flowing creeks. One was from a flowing mud bottom creek.

CORYPHAESCHNA INGENS (Rambur)

MARSHALL CO.—Spring Lake: 1 nymph, GHB, 11/9/47, *TU* 347.

NASIAESCHNA PENTACANTHA (Rambur)

COAHOMA CO.—1 male, 1 female, SAG, 1938, *UM* (data from L. G. Gloyd). OKTIBBEHA CO.—State College: 1 female, G. W. Bamberg, 7/9/23, *MSC*; 1 male, J. C. Barrett, 7/11/24, *MSC*.

EPIAESCHNA HEROS (Fabricius)

HANCOCK CO.—Pearlington: 2 males, GHB, 7/3/48, *TU* 607; 1 female, GHB and FHL, 7/24/48, *TU* 638. OKTIBBEHA CO.—State College: 1 female, B. H. McCain, April, 1918, *MSC*. PEARL RIVER CO.—Cybur: 1 male, GHB and FHL, 7/24/48, *TU* 640.

AESCHNA UMBROSA UMBROSA Walker

LAFAYETTE CO.—Oxford: 2 males, GHB, 10/24/47, *TU* 364; 4 males, GHB, 11/2/47, *TU* 361; 1 male, GHB, 11/5/47, *TU* 363; 1 male, GHB, 11/8/47, *TU* 362.

Since we have seen no records south of Tennessee these are apparently the most southerly for the species. Dr. Walker in personal communication stated: "This is considerably farther south than it has ever been taken before."

The species is represented by four collections of adult males. All were taken as they flew a regular course along a small shaded woodland stream. Walker (1912) states: "It is the last species to remain on the wing in the Autumn, sometimes flying, in the vicinity of Toronto, as late as the second week in October, and probably considerably later farther south." Collections on November 5 and 8 establish a late flying season for the South.

ANAX JUNIUS (Drury)

COAHOMA CO.—2 females, SAG, 1938, *UM*, (data from L. K. Gloyd). HANCOCK

Co.—Santa Rosa: 1 male, GHB and FHL, 8/21/48, *TU* 655. Kiln: 1 male, GHB and FHL, 8/21/48, *TU* 652. HARRISON Co.—Cat Island: 1 male, collector and date not given, *TU* 359. JACKSON Co.—Ocean Springs: 2 males, H. G. McGovern, October 1906, *MSC*. LAFAYETTE Co.—Oxford: 1 nymph, GHB, 11/28/47, *TU* 350; 1 adult, J. McLure, Spring 1948. MARSHALL Co.—Spring Lake: 1 nymph, GHB, 11/9/47, *TU* 348. MONTGOMERY Co.—Winona: 1 male, MCK, 8/25/47. OKTIBBEHA Co.—State College: 2 males, H. E. Weed, September 1896, *MSC;* 1 male, A. B. Carothers, 4/14/14, *MSC;* 1 nymph, J. W. Bailey, 4/19/14, *MSC*. PEARL RIVER Co.—Poplarville: 3 males, 2 females, GHB and FHL, 8/25/48, *TU* 653.

Adults are represented in the collections from April 14 to October. Many were observed in tandem at Kiln on August 21. Two collections of nymphs were both from mud bottom ponds in static water with an abundance of vegetation.

ANAX LONGIPES Hagen

HARRISON Co.—Pass Christian: "a number of examples," March, F. F. Hunt, (Davis, 1914).

Wright (1939) apparently doubts this record for he states that he "has collected in the vicinity of Pass Christian and other localities of like nature in the Central Gulf Coast, but has neither seen nor heard of any other collections of this species." All specimens seen by the author from the general vicinity of Pass Christian are *Anax junius*.

CORDULEGASTER MACULATUS Selys

WILKINSON Co.—Centerville: 1 nymph, GHP, 7/4/48, *TU* 578.

The one nymph is an early instar so that it is quite difficult to be certain of the specific determination.

MACROMIA ILLINOINENSIS Walsh

COAHOMA Co.—1 male, 1 female, SAG, 1938, *LKG,* (data from L. K. Gloyd).

Since such a large proportion of the nymphs in the genus are undescribed accurate specific identications are impossible. Collections of nymphs which checked more closely with *illinoinensis* than with any of the known nymphs are:

AMITE Co.—Gloster: 1 nymph, GHP, 7/4/48, *TU* 581. COVINGTON Co.—Hot Coffee: 7 nymphs, CLB, 7/3/48, *TU* 609. JEFFERSON DAVIS Co.—Prentiss 3 miles northeast: 6 nymphs, CLB, 7/10/48, *TU* 622. LAFAYETTE Co.—Oxford: 2 nymphs, GHB, 8/17/47, *TU* 330; 1 nymph, GHB, 10/4/47, *TU* 334. PIKE Co.—McComb: 1 nymph, GHP, 7/5/48, *TU* 586. NEWTON Co.—Chunky: 1 nymph, GHP, 8/22/37, *TU* 303.

All collections of nymphs were from sandy flowing creeks.

MACROMIA TAENIOLATA Rambur

LEFLORE Co.—Money: 1 male, MCK, 8/28/47.

DIDYMOPS TRANSVERSA (Say)

GEORGE Co.—Lucedale: 1 male, ALD, 4/5/30, *UM* (data from L. K. Gloyd).

EPICORDULIA PRINCEPS (Hagen)

LAFAYETTE Co.—Oxford: 2 males, MCK, 7/14/47, *TU* P-213.

NEUROCORDULIA VIRGINIENSIS Davis

AMITE Co.—Liberty: 1 nymph, GHP, 7/4/48, *TU* 583. COVINGTON Co.—Collins 9 miles west: 6 nymphs, CLB, 6/20/48, *TU* 394. LAFAYETTE Co.—Oxford: 2 nymphs, GHB, 7/26/47, *TU* 319; 2 nymphs, GHB, 8/3/47, *TU* 324; 3 nymphs,

GHB, 8/16/47, *TU* 328. MARION CO.—Sandy Hook: 1 nymph, 8/11/48, *TU* 765. MARSHALL CO.—Spring Lake: 1 nymph, GHB, 9/28/47, *TU* 331; 1 nymph, GHB, 10/18/47, *TU* 343. WILKINSON CO.—Centerville: 5 nymphs, GHP, 7/4/48, *TU* 579.

Information concerning the habitat of the nymphs appears to be conflicting. Needham and Heywood (1929, as *N. obsoleta*) state: "The senior author found numerous cast skins sticking to the swollen bases of cypress trees in Chipola Lake, Florida, in early April. Some were in the 'moss' (*Tillandsia*) that draped the cypresses, several feet above the water.

Byers (1930) states: "The nymphs . . . were found in the Santa Fe River, near Poe Springs. At the place of collection the water is three to four feet deep and very rapid, the bottom is rock strewn and practically devoid of vegetation, except for rock encrusting algae. In depressions on larger stones, usually on the upstream side, these nymphs were numerous."

Byers (1937) states: ". . . it would seem that *N. virginiensis* is markedly a river form. . . ."

Of the nine collections of nymphs, seven were from static water in ponds with mud bottoms, one was in rapidly flowing water just below an artificial dam with a sand bottom, and one from a static creek pot hole with a mud bottom. None were from large rapidly flowing rocky streams.

TETRAGONEURIA CYNOSURA (Say)

LAFAYETTE CO.—Oxford: 1 male, VWC, August 1947. OKTIBBEHA CO.—State College: 1 male, J. T. Douglass, 4/10/10, *MSC;* 1 male, F. P. Gary, April 1915, *MSC;* 1 male, R. T. Hobson, April 1919, *MSC;* 1 male, E. Gaillo, 7/12/24, *MSC;* 1 adult, abdomen missing, L. Bridges, 5/8/36, *MSC.*

Since such a large proportion of the nymphs in the genus are undescribed accurate specific identifications are impossible. Collections of nymphs which checked reasonably well with *cynosura* are:

LAFAYETTE CO.—Oxford: 12 nymphs, GHB, 1/10/48, *TU* 352. MARSHALL CO.—Spring Lake: 4 nymphs, GHB, 7/5/47, *TU* 311; 2 nymphs, GHB, 9/28/47, *TU* 332; 1 nymph, GHB, 11/9/47, *TU* 347; 1 nymph, GHB, 11/9/47, *TU* 348.

All nymphs were from shallow, mud bottom, static water with much vegetation.

HELOCORDULIA SELYSII (Hagen)

GEORGE CO.—Lucedale: 1 male, ALD, 3/19/31, *UM;* 1 male, 1 female, ALD, 4/29/31, *UM,* (data from L. K. Gloyd).

SOMATOCHLORA LINEARIS (Hagen)

CARROLL CO.—Vaiden: 1 female, MCK, 9/8/47, *TU* 366. GEORGE CO.—Lucedale: 1 male, ALD, 8/14/38, *UM,* (data from L. K. Gloyd).

These records from eastern and central Mississippi are a considerable extension of range. Walker (1925) gave no specific records for the Gulf States west of Georgia.

CELITHEMIS ELISA (Hagen)

OKTIBBEHA.—State College: 1 male, J. L. McReynolds, 5/15/21, *MSC;* 1 male, H. Martin, 4/4/36, *MSC.*

Needham and Heywood (1929) state that *elisa* is on the wing from June

to early September. The April 4 collection is a considerable extension of the flying season.

CELITHEMIS EPONINA (Drury)

HANCOCK.—Kiln: 1 female, GHB and FHL, 8/21/48, *TU* 650. OKTIBBEHA.—State College: 1 male, G. Blank, 6/25/21, *MSC*.

CELITHEMIS FASCIATA Kirby

HANCOCK CO.—Pearlington: 1 male, GHB, 7/3/48, *TU* 607; 2 males, 1 female, GHB and FHL, 7/24/48, *TU* 638. Gainesville: 1 male, 1 female, GHB and FHL, 7/24/48, *TU* 639. JACKSON CO.—Vancleave: 1 female, D. Weniger, 7/3/48, *TU* 598. LAFAYETTE CO.—Oxford: 1 male, CRB, 7/15/47, *TU* P-204. PEARL RIVER CO.—Cybur: 4 males, GHB and FHL, 7/24/48, *TU* 640.

Since such a large proportion of the nymphs in the genus are undescribed accurate specific identifications are impossible. Collections of nymphs which checked reasonably well with *fasciata* are:

MARSHALL CO.—Spring Lake: 5 nymphs, GHB, 7/5/47, *TU* 311; 1 nymph, GHB, 9/28/47, *TU* 332; 1 nymph, GHB, 10/5/47, *TU* 339; 3 nymphs, GHB, 10/18/47, *TU* 343; 8 nymphs, GHB, 11/9/47, *TU* 345, 346, 348.

All nymphs were from Spring Lake State Park. This is a large expanse of shallow static water with a mud bottom and with considerable vegetation. A single female was observed ovipositing on July 3 in a shallow heavily vegetated road side borrow pit at Pearlington.

PERITHEMIS TENERA (Say)

COAHOMA CO.—2 males, 2 females, SAG, 1938, *UM* (data from L. K. Gloyd). Lula: 12 males, 1 female, D. J. Bertucci, 8/31/48, *TU* 674. COVINGTON CO.—Collins 9 miles west: 1 nymph, CLB, 6/20/48, *TU* 394. HANCOCK.—Pearlington: 1 male, sight record, GHB, 7/3/48; 1 female GHB and FHL, 7/24/48, *TU* 638. Kiln: 1 male, GHB and FHL, 8/21/48, *TU* 651. HARRISON CO.—Biloxi: 2 males, S. Springer, 6/10/32, *UM;* 2 males, S. Springer, 5/28/32, *UM,* (data from L. K. Gloyd). LAFAYETTE CO.—Oxford: 1 nymph, GHB, 8/3/47, *TU* 324; 1 male, 1 female, VWC, August 1947; 1 male, 1 female, CRB, 7/17/47, *TU* P-205; 1 female, MMK, Summer 1947, *TU* P-222; 1 female, Z. Gore, July 1947, *TU* P-218; 1 female, MCK, 6/5/47. OKTIBBEHA.—State College: 1 male, J. C. Wilson, 4/27/34, *TU* P-199; 1 female, B. B. Shaw, 4/28/34, *TU* P-200; 1 male, G. F. Gray, 5/20/15, *MSC;* 1 female, E. B. Colmer, 6/14/19, *MSC;* 1 female, H. D. Stewart, 7/4/23, *MSC;* 1 male, J. R. Furr, 7/7/23, *MSC;* 1 male, V. Oswalt, 7/9/23, *MSC;* 1 female, I. Mills, June 1924, *MSC;* 1 male, G. C. Maddox, 9/26/24, *MSC;* 1 female, collector not given, 9/27/25, *MSC;* 1 male, collector not given, 9/26/25, *MSC;* 1 male, M. E. George, 4/10/35, *MSC;* 1 male, P. D. Tarter, 4/20/36, *MSC;* 1 male, 1 female, C. N. Godbold, 5/7/36, *MSC;* 1 female, C. N. Godbold, 5/9/36, *MSC*. PIKE CO.—McComb: 4 cast skins, GHP, 7/5/48, *TU* 585.

Three collections of nymphs were taken. All were from static mud bottom ponds. Needham and Heywood (1929) state that it appears on the wing at the end of May and flies through June. Based on these collections the flying season extends from May 10 to September 26.

LIBELLULA AXILLENA Westwood

HANCOCK CO.—Pearlington: 1 female, GHB, 7/3/48, *TU* 607; 1 male, GHB and FHL, 8/21/48, *TU* 648. HARRISON CO.—Biloxi: 1 male, S. Springer, 5/28/32, *UM,* (data from L. K. Gloyd). JACKSON CO.—Orange Grove: 1 male, H. L. Dozier, 7/8/20, *MSC*. OKTIBBEHA CO.—State College: 1 male, A. Smith, 4/8/30, *MSC*. PEARL RIVER CO.—Cybur: 4 males, GHB and FHL, 7/24/48, *TU* 640.

LIBELLULA AURIPENNIS Burmeister

CALHOUN CO.—Big Creek: 1 female, ALD, 6/18/29, *CU*, (Westfall, 1943). GEORGE CO.—Lucedale: 2 females, ALD, 7/17, 19/29, *CU*, (Westfall, 1943). Merrill: 1 female, ALD, 6/15/29, *CU*, (Westfall, 1943). HANCOCK CO.—Pearlington: 1 male, GHB, 7/3/48, *TU* 607; 3 males, GHB, 7/24/48, *TU* 637. JACKSON CO.—Ocean Springs: 2 males, R. P. Barahart, 7/6-10/21, *MSC*. OKTIBBEHA CO.—State College: 1 male, T. S. McGrew, 5/9/23, *MSC*. PEARL RIVER CO.—Poplarville: 1 male, GHB and FHL, 8/21/48, *TU* 653. PERRY CO.—New Augusta: 1 male, ALD, 7/12/29, *CU*, (Westfall, 1943).

LIBELLULA CYANEA Fabricius

COAHOMA CO.—2 males, 2 females, SAG, 1938, specimens discarded, (data from L. K. Gloyd). LAFAYETTE CO.—Oxford: 1 male, MCK, 6/25/47; 1 male, CRB, 7/25/47, *TU* P-208; 1 male, VWC, August 1947, *TU* 367.

LIBELLULA DEPLANATA Rambur

GEORGE CO.—Lucedale: 1 male, ALD, 4/10/30, *UM;* 1 female, ALD, 4/26/29, *UM*, (data from L. K. Gloyd). LAFAYETTE CO.—Oxford: 1 nymph, 1/10/48, *TU* 352.

One nymph was taken from a mud bottom road side borrow pit with an abundance of vegetation along with *T. cynosura, L. lydia, L. luctuosa, P. longipennis, E. simplicicollis.*

LIBELLULA FLAVIDA Rambur

GEORGE CO.—Lucedale: 1 male, ALD, 4/18/29, *UM;* 1 teneral female, ALD, 4/23/29, *UM;* 1 female, ALD, 4/26/29, *UM*, (data from L. K. Gloyd). JEFFERSON DAVIS CO.—Prentiss, 1 female, CLB, 6/19/48, *TU* 385. LAFAYETTE CO.—Oxford: 1 female, CRB, 7/15/48, *TU* P-204; 1 female, CRB, 7/20/48, *TU* P-207.

LIBELLULA INCESTA Hagen

COAHOMA CO.—2 females, SAG, 1938, *UM*, (data from L. K. Gloyd). COVINGTON CO.—Collins 9 miles west: 1 male, CLB, 6/20/48, *TU* 389. Collins 9 miles northwest: 1 male, CLB, 6/20/48, *TU* 390. Hot Coffee: 1 female, CLB, 7/3/48, *TU* 623. Collins: 1 female, CLB, 7/3/48, *TU* 627. HANCOCK CO.—Gainesville: 1 male, GHB and FHL, 7/24/48, *TU* 639. JASPER CO.—Montrose: 1 male, CRB, 7/4/47, *TU* P-203. LAFAYETTE CO.—Oxford: 1 male, 1 female, MMK, Summer 1947, *TU* P-222; 1 female, MCK, 6/25/47; 1 male, MCK, 7/17/47; 1 male, MMK, 7/22/47, *TU* P-214; 1 male, CRB, 7/28/47, *TU* P-209; 1 female, GHB, 8/3/47, *TU* 358; 1 male, GHB, 8/8/47, *TU* 359; 4 males, 1 female, VWC, August 1947. MARSHALL CO.—Spring Lake: 1 nymph, GHB, 9/28/47, *TU* 331. OKTIBBEHA CO.— State College: 1 male, J. Blackey, 8/25/13, *MSC*. PEARL RIVER CO.—McNeil: 1 male, GHB and FHL, 8/21/48, *TU* 654.

LIBELLULA LUCTUOSA Burmeister

LAFAYETTE CO.—Oxford: 4 nymphs, GHB, 1/10/48, *TU* 352; 1 male, 1 female, MCK, 6/25/47; 2 nymphs, GHB, 11/5/47, *TU* 344; 1 male, VWC, August 1947. MARSHALL CO.—Spring Lake: 11 nymphs, GHB, 9/28/47, *TU* 332; 1 nymph, GHB, 11/9/47, *TU* 346. OKTIBBEHA CO.—State College: 1 male, R. A. Hickman, 4/24/22, *MSC;* 1 male, R. F. Chilcoat, 5/11/23, *MSC;* 1 male, E. E. Smith, 7/9/24, *MSC;* 1 male, D. J. Bartlett, 5/6/35, *MSC;* 1 female, R. L. O'Barr, 5/23/35, *MSC*. YALOBUSHA CO.—1 female, Z. Gore, July 1947, *TU* P-217.

All four collections of nymphs were from static mud bottom ponds or from borrow pits.

LIBELLULA LYDIA Drury

AMITE Co.—Liberty: 3 nymphs, GHP, 7/4/48, *TU* 583. COAHOMA Co.—6 males, 6 females, SAG, 1938, *UM, LKG,* (data from L. K. Gloyd). Lula: 1 male, D. J. Bertucci, 8/31/48, *TU* 674. COVINGTON Co.—Prentiss: 20 nymphs, CLB, 6/19/48, *TU* 393. Collins 9 miles west: 1 nymph, CLB, 6/20/48, *TU* 394. HANCOCK Co.—Pearlington: 1 male, 1 female, GHB and FHL, 7/24/48, *TU* 638. Kiln: 1 female, GHB and FHL, 8/21/48, *TU* 651. HARRISON Co.—Biloxi: 1 male, S. Springer, 5/28/32, *UM;* 1 female, S Springer, 6/4/32, *UM,* (data from L. K. Gloyd). JASPER Co.—Montrose: 1 female, CRB, 7/4/47, *TU* P-203. JEFFERSON DAVIS Co.—Prentiss: 1 male, 1 female, CLB, 6/19/48, *TU* 387. LAFAYETTE Co.—Oxford: 1 male, CRB, 7/15/47, *TU* P-203; 4 females, 1 male, MMK, Summer 1947, *TU* P-222; 1 male, MMK, 7/14/47, *TU* P-213; 1 male, 1 female, GHB, 7/19/47, *TU* 356; 2 females, 1 male, GHB, 8/8/47, *TU* 359; 1 female, Z. Gore, June 1947, *TU* P-216; 1 male, Z. Gore, July 1947, *TU* P-218; 3 males, 1 female, MCK, 6/25/47; 2 males, 1 female, VWC, July 1947; 4 nymphs, GHB, 7/26/47, *TU* 319; 1 nymph, GHB, 8/16/47, *TU* 329; 8 nymphs, GHB, 8/16/47, *TU* 327; 1 nymph, GHB, 11/5/47, *TU* 344; 1 nymph, GHB, 11/28/47, *TU* 350; 6 nymphs, GHB, 1/10/48, *TU* 352. MONTGOMERY Co.—Winona: 1 male, MCK, 7/19/47. OKTIBBEHA Co.—State College: 1 female, M. E. Harding, 5/23/14; 1 male, C. M. Griffin, 4/5/18; 1 female, J. I. Tims, 5/4/18; 1 male, M. Echares, 5/10/18; 1 male, R. D. Morrow, 4/22/21; 1 male, G. P. Lucas, 4/23/21; 1 male, J. H. Bailey, 6/10/21; 1 male, H. C. Johnson, Summer 1924; 1 female, R. O. Cohier, 5/9/24; 1 male, collector not given, 9/22/25; 1 male, E. R. Johnson, 4/11/26; 1 male, J. S. Cottingham, 4/20/26; 1 female, W. W. Gavin, 5/11/26; 2 males, J. C. Dilworth, March 1927; 1 male, E. E. Rogers, 4/8/27; 1 male, W. G. Jacks, 4/10/27; 1 male, W. R. Meredith, 4/19/27; 1 male, H. R. Adair, 4/25/27; 1 female, I. R. Graham, 5/2/27; 1 male, 1 female, C. V. Cummins, 5/21/27; 1 female, C. E. Flanagan, 4/10/28; 1 male, C. D. Huston, 4/20/28; 1 male, T. R. O. Bryant, 5/20/28; 1 male, L. V. Edwards, 5/10/29; 1 male, G. M. Moore, 3/25/30; 1 male, S. N. Johnson, 5/5/30; 1 female, J. T. McMinn, 5/5/30; 1 male, B. T. Hurst, 6/25/30; 1 female, H. H. Martin, 4/1/36; 1 female C. N. Godbold, 4/17/36; 1 male, B. M. Trapp, 5/9/36; 1 male, R. L. O'Barr, 5/26/45. All *MSC.* PEARL RIVER Co.—Poplarville: 1 male, GHB and FHL, 8/21/48, *TU* 633. WARREN Co.—Vicksburg: 1 male, 1 female, GD, date not given, *INHS,* (data from L. K. Gloyd). WILKINSON Co.—Centerville: 2 nymphs, GHP, 7/4/48, *TU* 579.

All ten collections of nymphs were from static mud bottom ponds, pot holes, or borrow pits. Adults are represented in the collections from March 25 to September 22. Brimley (1903) long ago stated that *lydia* is common from March to October and has the longest flying season of any of our dragonflies.

LIBELLULA NEEDHAMI Westfall

HANCOCK Co.—Pearlington: 1 male, 1 female, GHB and FHL, 7/24/48, *TU* 638; 1 male, GHB and FHL, 7/24/48, *TU* 637; 1 male GHB and FHL, 8/21/48, *TU* 648. HARRISON Co.—Gulfport: 1 male, Miss Unwin, date not given, *CU,* (Westfall, 1943). JACKSON Co.—Ocean Springs: 1 male, 2 females, ALD, 6/24/30,*CU;* 1 female, ALD, 6/22/30, *UM,* (Westfall, 1943). PEARL RIVER Co.—Cybur: 1 male, GHB and FHL, 7/24/48, *TU* 640.

LIBELLULA PULCHELLA Drury

COAHOMA Co.—2 males, SAG, 1938, *UM,* (data from L. K. Gloyd). LAFAYETTE Co.—Oxford: 1 male, J. McLure, Spring 1948. MONTGOMERY Co.—Winona: 1 male, MCK, 8/8/47. OKTIBBEHA Co.—State College: 1 male, B. B. Shaw, 5/10/34, *TU* P-225; 1 female, R. W. Harned, 9/4/09, *MSC;* 1 male, H. Burkes, 5/16/30, *MSC.* SMITH Co.—Mize: 1 male, R. E. Norris, without date, *MSC.* TIPPAH Co.—Ripley: 1 male, H. E. Wallace, 9/1/19, *MSC.*

Adults are represented in the collections from May 10 to September 4.

LIBELLULA SEMIFASCIATA Burmeister

OKTIBBEHA CO.—State College: 1 male, E. E. Smith, 7/18/24, *MSC;* 1 adult, abdomen missing, J. A. Harris, April 1925, *MSC;* 1 female, G. W. Jones, April 1930, *MSC;* 1 female, J. A. Mac Lemope, 5/1/20, *MSC;* 1 male, A. L. McCay, 4/20/19, *MSC.* PEARL RIVER CO.—Cybur: 1 male, GHB and FHL, 7/24/48, *TU* 640.

LIBELLULA VIBRANS Fabricius

COAHOMA CO.—3 males, 5 females, SAG, 1938, *UM* (data from L. K. Gloyd). HANCOCK CO.—Picayune: 2 nymphs, R. Lee, 5/2/48, *TU* 305. Gainesville: 1 female, GHB and FHL, 7/24/48, *TU* 639. Pearlington: 2 males, GHB and FHL, 7/24/48, *TU* 638; 1 male, 2 females, GHB and FHL, 8/21/48, *TU* 648. HARRISON CO.—Biloxi: 2 males, S. Springer, 6/4/32, *UM,* (data from L. K. Gloyd). JEFFERSON DAVIS CO.—Prentiss 3 miles northeast: 1 female, CLB, 7/10/48, *TU* 624. Prentiss: 2 females, CLB, 7/3/48, *TU* 626. MONTGOMERY CO.—Winona: 1 male, MCK, 9/5/47. OKTIBBEHA CO.—State College: 1 adult, abdomen missing, R. H. Martin, 12/8/24, *MSC;* 1 female, B. B. Jones, 9/3/24, *MSC.* SMITH CO.—Mize: 2 males, B. E. Norris, Summer 1924, *MSC.*

Adults are represented in the collections from May 2 to December 8. The December date is an unusually late seasonal record. However, Wright (1939) states that other species (*Erythemis simplicicollis, Pachidiplax longipennis,* and *Tramea carolina*) were taken occasionally as late as early December in the Central Gulf Coast Region.

ORTHEMIS FERRUGINEA (Fabricius)

HARRISON CO.—Biloxi: 3 males, S. Springer, 6/10/32, *UM;* 1 female, S. Springer, 5/28/32, *UM,* (data from L. K. Gloyd). PEARL RIVER CO.—Poplarville: 1 male, GHB and FHL, 8/21/48, *TU* 653.

SYMPETRUM AMBIGUUM (Rambur)

LAFAYETTE CO.—Oxford: 2 males, GHB, 10/24/47, *TU* 360; 1 male, GHB, 11/5/47, *TU* 365. OKTIBBEHA CO.—State College: R. G. Collier, 11/4 year not given, *MSC.*

SYMPETRUM CORRUPTUM (Hagen)

HARRISON CO.—Deer Island: 1 male, G. Kislanre, 4/1/26, *MSC.* OKTIBBEHA CO.—State College: 1 adult, abdomen missing, J. K. Holloway, 9/11/24, *MSC.*

ERYTHRODIPLAX BERENICE (Drury)

HANCOCK CO.—Ansley: 1 female, FHL, 4/18/48, *TU* 294. HARRISON CO.—Henderson Point: 2 males, 7 females, T. H. Hubbel, 6/2/26, in collection of Caraten Ahrens, (Borror, 1942). Deer Island: 4 females, D. Weniger, 7/5/48, *TU* 599. Biloxi: 2 males, 4 females, C. C. Deam, 7/7/90, *UM,* (Borror, 1942).

ERTHRODIPLAX CONNATA MINUSCULA (Rambur)

HARRISON CO.—Cat Island: Spring 1933, (Wright, 1937, 1943); 2 females M. Wright, without date, *TU* P-195. Biloxi: 6 males 4 females, C. C. Deam, 7/17/90, *UM,* (Borror, 1942).

PACHIDIPLAX LONGIPENNIS (Burmeister)

COAHOMA CO.—4 males, 3 females, SAG, 1938, *LKG, UM,* (data from L. K. Gloyd). COVINGTON CO.—Prentiss: 2 males, 1 female, CLB, 6/19/48, *TU* 388. Collins 9 miles west: 1 male, CLB, 6/20/48, *TU* 389. Collins 9 miles northwest: 2

males, CLB, 6/20/48, *TU* 390. Collins: 1 nymph, CLB, 7/3/48, *TU* 608. HANCOCK Co.—Pearlington: 1 male, GHB and FHL, 7/24/48, *TU* 637; 3 males, 1 female, GHB and FHL, 7/24/48, *TU* 638; 1 male, 1 female, GHB and FHL, 8/21/48, *TU* 649; 1 male, GHB, 7/3/48, *TU* 607. Gainesville: 1 male, 1 female, GHB and FHL, 7/24/48, *TU* 639. Santa Rosa: 1 male, GHB and FHL, 8/21/48, *TU* 655. Kiln: 1 male, GHB and FHL, 8/21/48, *TU* 651; 2 males, 1 female, GHB and FHL, 8/21/48, *TU* 650. HARRISON Co.—Pass Christian: 24 nymphs, S. Ward, 4/25/48, *TU* 304. Biloxi: 2 males, S. Springer, 6/10/32, *UM;* 1 female, S. Springer, 5/28/32, *UM;* 1 male, 1 female, S. Springer, 5/30/32, *UM,* (data from L. K. Gloyd). JEFFERSON DAVIS Co.—Prentiss: 1 male, 1 female, CLB, 6/19/48, *TU* 385; 1 female, CLB, 6/19/48, *TU* 386; 1 female, CLB, 7/10/48, *TU* 625; 2 females, CLB, 7/10/48, *TU* 626. Prentiss 3 miles northeast: 2 females, CLB, 7/10/48, *TU* 624. LAFAYETTE Co.—Oxford: 3 males, GHB, 7/26/47, *TU* 357; 2 females, GHB, 8/3/47, *TU* 358; 8 nymphs, GHB, 8/3/47, *TU* 324; 1 nymph, GHB, 8/16/47, *TU* 328; 3 nymphs, GHB, 8/16/47, *TU* 329; 1 nymph, GHB, 1/10/48, *TU* 352; 1 male, 1 female, MMK, Summer 1947, *TU* P-222; 1 female, MCK, 6/25/47; 1 female, CRB, 7/17/47, *TU* P-205; 1 male, CRB, 7/28/47, *TU* P-209; 1 male, MMK, 7/22/47, *TU* P-214; 1 female, Z. Gore, July 1947, *TU* P-218; 3 males, 1 female, VWC, August 1947. MARSHALL Co.—Spring Lake: 1 nymph, GHB, 11/9/47, *TU* 348. OKTIBBEHA Co.—State College: 1 adult, abdomen missing, I. Jopet, 5/15/15, *MSC;* 1 female, O. M. Chance, 5/1/19, *MSC;* 1 male, M. H. Mabry, 4/14/19, *MSC;* 1 adult, abdomen missing, R. D. Rawls, 5/22/21, *MSC;* 1 male, H. H. Martin, 4/4/36, *MSC;* 1 male, P. D. Carter, 5/3/36, *MSC.* PEARL RIVER Co.—Picayune: 1 male, R. Lee, 5/2/48, *TU* 306. Cybur: 1 male, GHB and FHL, 7/24/48, *TU* 640. McNeil: 1 female, GHB and FHL, 8/21/48, *TU* 654. PONTOTOC Co.—Pontotoc: 1 male, G .Y. Donaldson, 7/1/24, *MSC.* STONE Co.—Perkinston: 2 females, D. Weninger, 7/15/48, *TU* 700. WILKINSON Co.—Centerville: 2 males, GHP, 7/4/48, *TU* 580; 8 nymphs, GHP, 7/4/48, *TU* 579. YALOBUSHA Co.—1 female, Z. Gore, July 1947, *TU* P-217.

All eight collections of nymphs were from static water with mud bottoms, in ponds, borrow pits or creek pot holes. The earliest adult collection was April 4.

ERYTHEMIS SIMPLICICOLLIS (Say)

HANCOCK Co.—Kiln: 1 male, 1 female, GHB and FHL, 8/21/48, *TU* 650. Pearlington: 1 female, GHB and FHL, 8/21/48, *TU* 649; 2 males, GHB, 7/3/48, *TU* 607. Santa Rosa: 1 female, GHB and FHL, 8/21/48, *TU* 655. HARRISON Co.—Pass Christian: 14 nymphs, S. Ward, 4/25/48, *TU* 304. Biloxi: 1 female, S. Springer, 5/30/32, *UM,* (data from L. K. Gloyd). JACKSON Co.—Vancleave: 1 male, 1 female, D. Weniger, 7/3/48, *TU* 598. JASPER Co.—Montrose: 1 female, CRB, 7/4/47, *TU* P-203. JEFFERSON DAVIS Co.—Bassfield: 1 nymph, F. Cagle, 4/17/48, *TU* 700. LAFAYETTE Co.—Oxford: 2 nymphs, GHB, 7/26/47, *TU* 319; 1 female, GHB, 8/3/47, *TU* 358; 1 female, 1 male, GHB, 8/8/47, *TU* 359; 2 nymphs, GHB, 8/16/47, *TU* 327; 1 nymph, GHB, 1/10/48, *TU* 352; 1 female, MMK, Summer 1947, *TU* P-222; 1 male, 1 female, MCK, 6/25/47; 1 male, 1 female, Z. Gore, July 1947, *TU* P-218; 1 female, VWC, July 1947; 1 female, CRB, 7/1/47, *TU* P-202; 1 male, CRB, 7/25/47, *TU* P.208. MARSHALL Co.—Spring Lake: 5 nymphs, GHB, 7/5/47, *TU* 311; 3 nymphs, GHB, 9/28/47, *TU* 332; 5 nymphs, GHB, 10/18/47, *TU* 338, 337, 343; 10 nymphs, GHB, 11/9/47, *TU* 345, 346. OKTIBBEHA Co.—State College: 1 male, E. E. Gross, 7/19/23, *MSC;* 1 female, M. H. McMullin, 8/1/23, *MSC;* 1 female, N. L. Gray, 7/20/24, *MSC;* 1 male, H. R. Smith, 5/4/30, *MSC;* 1 male, D. J. Bartlett, 5/2/35, *MSC;* 1 female, R. L. O'Barr, 5/26/35, *MSC;* 1 male, D. J. Bartlett, 6/20/35, *MSC.*

Of the twelve collections of nymphs 11 were from static water with mud bottoms in ponds or borrow pits. A single collection was from a flowing sand bottom creek. The earliest adult collection was June 2nd.

MACRODIPLAX BALTEATA (Hagen)

JACKSON CO.—Petit Bois Island: adult, 7/15/34, (Wright, 1939, 1943).

TRAPEZOSTIGMA CAROLINA (L.)

HANCOCK CO.—Kiln: 3 males, 4 females, GHB and FHL, 8/21/48, *TU* 652; 1 male, GHB and FHL, 8/21/48, *TU* 650. LAFAYETTE CO.—Oxford: 1 male, VWC, August 1948, *TU* 643; 1 male, GHB, 8/8/48, *TU* 359; 1 male, J. McLure, Spring 1948. MARSHALL CO.—Spring Lake: 5 nymphs, GHB, 7/5/47, *TU* 311. OKTIBBEHA CO.—State College: 1 male, E. Buchler, 4/13/19, *MSC;* 1 female, R. D. Morrow, 4/22/21, *MSC;* 1 male, G. P. Lucas, 4/23/23, *MSC;* 1 male, S. W. Box, 5/15/21, *MSC;* 1 male, M. V. Ward, 3/20/34, *TU* P-196; 1 male, W. C. Pearce, April 1934, *TU* P-197. PEARL RIVER CO.—Picayune: 1 male, R. Lee, 5/2/48, *TU* 306. Cybur: 3 females, GHB and FHL, 7/24/48, *TU* 640. WILKINSON CO.—Centerville: 3 nymphs, GHP, 7/4/48, *TU* 579.

Many were observed in tandem and egg laying in a large pine land pond near Kiln on August 21.

Each of the two collections of nymphs was from static water in mud bottom ponds. The earliest seasonal record for the adults was March 20.

TRAPEZOSTIGMA LACERATA (Hagen)

COAHOMA CO.—3 males, 1 female, SAG, 1938, *UM, LKG,* (data from L. K. Gloyd). HANCOCK CO.—Santa Rosa: 1 male, GHB and FHL, 8/21/48, *TU* 655. LAFAYETTE CO.—Oxford: 1 male, J. McLure, Spring 1948. MONTGOMERY CO.—Winona: 1 male, MCK, 8/23/47. OKTIBBEHA CO.—State College: 1 male, M. E. Kelly, 4/10/19, *MSC;* 1 male, J. T. Douglass, 4/14/19, *MSC;* 1 male, G. Y. Donaldson, 3/1/24, *MSC.*

TRAPEZOSTIGMA ONUSTA (Hagen)

COAHOMA CO.—1 male, SAG, 1938, *UM,* (data from L. K. Gloyd). LAFAYETTE CO.—Oxford: 1 male, MMK, 7/22/47, *TU* P-214; 1 male, MMK, Summer 1947, *TU* P-222. OKTIBBEHA CO.—State College: 1 male, J. K. Luter, 5/6/34, *TU* P-201. SIMPSON CO.—Harrisville: 1 male, L. Bidges, 5/7/36, *MSC.*

PANTALA FLAVESCENS (Fabricius)

COAHOMA CO.—3 males, 1 female, SAG, 1938, *LKG,* (data from L. K. Gloyd). MONTGOMERY CO.—Winona: 1 male, MCK, 7/19/47. OKTIBBEHA CO.—State College: 1 female, R. Melvin, 3/25/25, *MSC.* PFARL RIVER CO.—Poplarville: 1 male, GHB and FHL, 8/21/48, *TU* 653.

PANTALA HYMENEA (Say)

HARRISON CO.—Cat Island: 2 nymphs, E. S. Hathaway, 5/20/35, *TU* 302. HANCOCK CO.—Pearlington: 1 cast skin, GHB and FHL, 8/21/48, *TU* 659.

One cast skin was collected about one foot above water level in a heavily vegetated roadside borrow pit on August 21.

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The Drosophila of Jackson Hole, Wyoming — A Taxonomic and Ecological Survey

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Introduction

In the time at our disposal a preliminary study of the species of the genus *Drosophila* and their ecological distribution in the Jackson Hole area was undertaken. This project was made possible through a grant from the Jackson Hole Wildlife Park and constitutes a small part of the survey of the flora and fauna of this region being carried on at the Wildlife Laboratory in the Park. The author wishes to thank the directors of the Wildlife Park for this grant and Mr. James R. Simon and Dr. Robert K. Enders for the courtesies extended during his stay at the laboratory. Miss Rada Demerec served as research assistant and it is a pleasure to acknowledge her efficient help in the project. Large samples of populations of two of the native species have been saved and will be used in the studies on the genetics of populations which the author has undertaken.

Methods

Traps or rather lures, consisting of paper drinking cups suspended by strings and half filled with a yeasted banana mash, serving as bait, were hung from bushes or the low branches of trees. Much experience has shown that this bait is superior to any other in attracting *Drosophila* to the traps. In the collecting areas listed in Table 2 and in two other areas not listed because of the small catch, approximately 600 such traps were placed. In these traps about 125 pounds of mashed ripe bananas mixed with baker's yeast were used.

Drosophila are attracted to these lures twice during a twenty-four hour period, in the morning and in the evening. The chief factors involved in this diurnal cycle of activity are temperature, light, and relative humidity. Combinations of these three factors are important. In general it seems that the flies seek cover and avoid the traps during the heat of the day and the low temperature period of the night. These small flies avoid direct sunlight. In the eastern United States during hot summer periods it has been our experience that very good collections could be made in the early morning soon after sunrise. However, in the Jackson Hole area very few flies visit the traps in the morning. This is probably due to the combination of low air temperature in the cover where the flies spend the night and very sudden rise in temperature and light intensity after sunrise. Thus by the time the temperature in the cover where the flies spend the night is high enough to induce activity, the light and heat of radiation from the sun have become so intense that the flies will not ven-

ture to the traps. In the evening for a short period, favorable temperature and light coincide and many more flies visit the traps.

As both of these variable factors play an important role, the peak collecting is reached at different times and at different temperatures from day to day. In general, the collecting period on a clear day lasts for about an hour to an hour and a half. After a slow increase in the number of flies coming to the traps a peak of from fifteen minutes to a half hour is reached. The collecting then suddenly decreases as the light fades and the temperature drops rapidly. The longest period of maximum collecting will be found on a still, cloudy late afternoon and evening following a warm mid-day. Under these circumstances optimum light and temperature factors coincide over a longer time. Relative humidity, which varies with temperature, also plays a role. Wind is another important factor. Few flies leave cover to visit the traps on a windy evening. While the number of flies collected in the morning and evening in August in the eastern U. S. will often be about equal, it has been our experience here that perhaps ten times as many flies can be secured in the evening collection. The bulk of our collection was consequently made in the evening. On the average during August of 1948 the peak collecting came at about 6:00 P. M. with temperature about 20°C to 22°C. In general our observations on collecting corroborate those made by Dr. Th. Dobzhansky and Dr. Carl Epling on *D. pseudoobscura* (Dobzhansky and Epling, 1944).

Flies were taken from the paper cup lures by means of a "collector." This is a hollow cardboard cylinder about nine inches long and five inches in diameter, covered at one end with a single layer of fine-mesh cheese-cloth. The cylinder is carried in one hand, with the covered end slightly higher than the open end and brought suddenly near the suspended cup. The cup is grasped with the other hand and carried up into the cylinder and shaken or tapped against the side of the cylinder. Flies which have been feeding on the banana mash are disturbed and fly up to the cheese-cloth cover as they are positively phototropic and negatively geotropic. Most of the flies remain at the upper, lighted end of the cylinder and several traps may be collected from successively in this way. Then a large cotton plug is inserted in the open end of the cylinder and pushed up near the cheese-cloth. The cylinder is set upright with cheese-cloth end up; a few drops of ether are placed on a piece of cleansing tissue. This is laid on the cheese-cloth and a cover placed over this end of the cylinder. When flies are anaesthetized the cotton plug is removed and they are shaken onto a folded sheet of card-board and then transferred to a vial containing food for transport back to the laboratory. In the laboratory the catch is re-etherized and a count and tabulation according to species and sex are made.

COLLECTING STATIONS

A brief description of the ten collecting stations follows. As large a variety of habitats was chosen as seemed practicable in the time available.

Area around Laboratory and Mess-hall.—Preliminary collections were made in the vicinity of the laboratory and mess-hall. Over one hundred traps were set in the willows and around the garbage pile near the mess hall, in the wil-

lows along the road between the mess-hall and laboratory, in the lodge-pole pine grove back of the laboratory, and in the willows near the Snake River. The altitude here is approximately 6700 feet. Reference to Table 2 will show that four of the five native species collected were taken in these traps. However, the trapping here was poor in respect to numbers of flies secured.

Pacific Creek Station.—Miss Demerec collected for four days in the Teton Wilderness near the north bank of Pacific Creek about a mile west of the point where Whetstone Creek joins Pacific Creek; approximate elevation, 7600 feet. Traps were set in mixed conifer and aspen near water, either stream or marsh.

Summit of Signal Mountain.—Traps were set on the west slope of Signal Mountain just below the summit; approximate elevation, 7700 feet. The forest here is mixed conifer, predominantly lodge-pole pine with a scanty undergrowth of blueberry. Collecting here was poor. Thirty traps one evening and sixty traps a second evening yielded only 156 flies.

Half-way up Signal Mountain.—Traps were set in the dense lodge-pole pine forest with a good undergrowth of blueberry along the Signal Mountain road about half-way between base and summit; elevation, about 7200 feet. Collecting at this site was good, even though there was no stream or marsh near.

Base of Signal Mountain.—Some traps were set in the willows around a pond near the base of Signal Mountain. A larger number of traps were set in the open lodge-pole pine forest some distance from the pond. There was a good undergrowth of dwarf blueberry; elevation, about 6800 feet. Collecting here was fair.

Foot of Teton Glacier Trail (Marsh Area).—Traps were set in willows along a marsh at the foot of the Teton Glacier trail and at the edge of the mixed conifer forest near the marsh; elevation, about 6750 feet. One of our largest collections was made here, and almost half of the specimens of *D. montana* were taken at this collecting station.

Teton Glacier Trail (Glacial Stream Area).—Traps were set in the mixed conifer forest just off the Glacier Trail and near a stream coming from the Teton Glacier. There was a heavy undergrowth here, including blueberry bushes; elevation, about 6900 feet. Collecting was good at this point.

Teton Glacier Trail (Lake Surprise Area).—Twenty-five traps were set in the Engelmann spruce forest above Surprise Lake at 5:00 P. M., August 20th at an altitude of about 9675 feet. On August 22nd these traps were carefully examined at 4:00 P. M. to 4:30 P. M., following a light shower; temperature 10°C. Two specimens of *D. suboccidentalis* were taken and no others were present in the traps. At 5:15 P. M. the sun was shining and the temperature had risen to 11.5°C. By 5:30 P. M. the temperature had dropped to 10°C. Two more flies of the same species were taken in this period. These two flies had come to the traps between 4:30 P. M. and 5:15 P. M. This was a very small catch but did establish that this species was living at an altitude of almost 10,000 feet, the highest altitude at which *Drosophila* have been taken in this latitude.

Lily Pond Area near Jackson Lake Boat-house.—Traps were set in the willows and aspens along the edge of a lily pond near the Moran Jackson Road and separated from Jackson Lake by a low ridge; elevation, about 6750 feet. Collecting here was relatively poor in numbers but interesting in species distribution, with many more *D. subquinaria* and almost as many *D. montana* as *D. suboccidentalis.*

Grocery in Jackson, Wyoming.—In the grocery in Jackson, Wyoming, where bananas for bait were purchased, many specimens of *D. melanogaster* were observed and a few of these were captured. One specimen of *D. suboccidentalis* was taken in this grocery.

TAXONOMIC AND ECOLOGICAL NOTES BASED ON COLLECTIONS

In Table 1, taken from Patterson (1943), is given the summary of previous collection records for this genus made by Mainland and Wheeler for the state of Wyoming. In Table 2 our collection records for the Jackson Hole area are given. Ecological and taxonomic observations on each species collected are presented below.

DROSOPHILA SUBOCCIDENTALIS

On the basis of our collection records *Drosophila suboccidentalis* (Spencer, 1942) is the dominant species of the genus in the Jackson Hole area. 4048 specimens, over 76% of our total collection, were of this species. While *suboccidentalis* was taken at all of the ten collecting areas, the greatest numbers were found in lodge-pole pine forests with an undergrowth of blueberry. Several specimens were found with the abdomen purplish-blue from collections where blueberries were abundant. These flies had evidently been feeding on blueberries, the skin of which had probably been broken by some other animal. A few flies were found in traps in which crushed blueberry was used as bait. In marshy areas where willow and aspen predominate this species was found in relatively small numbers. It was the only species collected near Surprise Lake at an elevation of about 9675 feet, and formed over 93% of the collection from near the summit of Signal Mountain.

Some specimens taken showed much variability in color from the type form. The original description of this species (Spencer, 1942) states: "Mesonotum light brown, shiny. Scutellum light brown, shiny. Legs light brown. . . .Abdomen of male shiny yellow; a dark apical band on tergites 2, 3, 4, and 5 narrowly interrupted in mid-dorsal line and reaching 2/3 distance to lateral margin of tergite. . . . Abdomen of female shiny yellow; a dark brown apical band on tergites 2, 3, 4, and 5 narrowly interrupted in mid-dorsal line and reaching 2/3 distance to lateral margin of tergite; band on tergite 5 tending to break into 2 parts on either side; dark brown area not interrupted in mid-dorsal line in tergites 6 and 7." In many specimens collected, the mesonotum showed a darker median longitudinal stripe and in others the mesonotum and scutellum were uniformly dark brown. In these individuals the abdominal tergites were also dark brown, obscuring or obliterating the color pattern described above. Generally these darkly pigmented individuals, both male and female, were relatively small. In *Drosophila putrida* such dark specimens have often been collected, but progeny from them show the typical color pattern,

indicating that the dark color pattern is due to some environmental factor. Tests will be run to determine whether the color variations in *D. suboccidentalis* are hereditary or environmental. Other diagnostic characters on these dark specimens indicate that they are typical *suboccidentalis*.

DROSOPHILA SUBQUINARIA

864 specimens of *Drosophila subquinaria*, 16% of our total collection, were taken. While this species was found at the summit and half-way up Signal Mountain in lodge-pole pine forest and far from any body of water it can be taken in much larger numbers in marshy areas and near swamps and ponds. In the aspens at the edge of the lily pond near the Jackson Lake boat-house over three times as many *D. subquinaria* as *D. suboccidentalis* were caught. In absolute as well as relative numbers *subquinaria* are found more abundantly near water. The ecological distribution of *subquinaria* and *suboccidentalis* in the Jackson Hole area is similar to that of the closely related species, *quinaria* and *transversa*, in the eastern United States. Here *quinaria* is generally taken in relatively moist habitat and *transversa* in larger numbers in heavily wooded regions often far from water. All four species belong to the *quinaria* group of the genus *Drosophila*, a group considered to be primarily fungus feeders.

To a lesser extent than in *suboccidentalis*, color variants were found in this species. In some specimens the abdominal tergites were so dark as to obscure the spotted color pattern. In the original description of this species (Spencer, 1942) the color pattern of the abdomen is described as follows: "Abdomen of male yellow; tergites 2, 3, 4, 5 with 4 prominent black spots on each; 2 large black spots on tergite 6; spots tend to be triangular, but may be somewhat united; narrow, dark lateral margins on each tergite. . . . In the female abdominal tergites 2, 3, 4, 5, 6 with 4 prominent black spots on each; also narrow, dark lateral margins on each tergite; spots may be somewhat united." Specimens were found in which the spots, particularly on the anterior tergites, were fused into a dark band. Males of this type could easily be distinguished from males of *suboccidentalis* by the garniture of medial, recurved tarsal hairs on the latter, but a few of the females collected were difficult to classify, as the abdominal color pattern is the best diagnostic character. In a number of cases in the genus, the males of closely related species can easily be distinguished but the females cannot be certainly classified. A large collection of living specimens of *subquinaria* has been saved for further study. Progenies from individual females will be reared to determine whether the color variations seen in wild specimens are inherited.

DROSOPHILA MONTANA

Drosophila montana was described by Patterson and Wheeler (1942). In our collection 323 flies, about 6% of the total, were of this species. We found *D. montana* exclusively near water, either in marshy areas or near a stream or pond. Possibly it may be taken in other habitats but our collections are extensive enough to indicate a preference for a moist habitat. No specimens of this species were taken in the large collection from half-way up Signal Mountain or from the summit of Signal Mountain. Most of the large collection at

the base of Signal Mountain came from lodge-pole pine forest and the six specimens of this species taken in this area were probably from traps hung in willows near the Beaver Pond.

Patterson and Wheeler (1942) state: "This species has two color phases, light and dark. The description is based on the darker form. The light form has a color pattern similar to that of *D. novamexicana* but it has the same metaphase configuration of chromosomes as the darker form." Among the specimens collected were a few of the light form. Living specimens of both color phases have been saved and the inheritance of this character will be studied.

DROSOPHILA ATHABASCA

In a collection of 2386 *Drosophila* from Wyoming (see Table 1) made by Mainland and Wheeler, 342 specimens of *Drosophila athabasca* were reported. In our larger collection only 39 flies of this species were found. *D. athabasca* is the most widely distributed native species of *Drosophila* in the U. S. A. (Patterson and Wagner, 1943). Its range is from coast to coast, as far south as Tennessee in the east and New Mexico in the west, and north into Canada and Alaska. We have found in Ohio that this species is taken in large numbers in cool, damp weather and the numbers become greatly reduced in dry, hot weather. This summer has been exceptionally dry in Jackson Hole, which may account for the small number of this species collected. Specimens were taken, however, at all collecting areas except the summit of Signal Mountain and Lake Surprise. The numbers of individuals is too small to draw any conclusions concerning habitat preferences.

DROSOPHILA PSEUDOOBSCURA

Drosophila pseudoobscura has a wide range in the western part of the U. S. A. from Canada to Central America and from the west coast to the Black Hills, central Nebraska and central Texas. Throughout much of the mountainous area of the West it is the dominant species. In collecting in the Sierra Nevadas, San Gabriel Mountains of southern California and in southern Colorado, 90% or more of the flies have been *pseudoobscura*. Mainland and Wheeler record 63 specimens (Table 1) out of 2386 *Drosophila* taken in Wyoming, indicating that the species is much less abundant than further west. In our collection only two specimes, both males, were taken. The dry season does not entirely explain the scarcity of the species as it may be taken in large numbers in piñon pine forests on desert mountain ranges and in the lower Sierras, where there is practically no summer rainfall and little green undergrowth in the yellow pine forests. This species is certainly found more abundantly in upper Sonoran and transitional zones in the Sierras and elsewhere than in the Canadian zone. We may conclude that the *pseudoobscura* population in the Jackson Hole area is relatively sparse and perhaps further reduced by the dry summer of 1948.

DROSOPHILA MELANOGASTER

Drosophila melanogaster is a tropical species which has been introduced into the U. S. A., and forms large populations in cities, towns, and villages.

Its present distribution is world-wide, carried on shipments of fruit and other produce. Wherever man is found, at least in temperate and tropical climates, colonies of *D. melanogaster* may be expected. In Jackson it was observed in large numbers in a grocery and a few specimens were collected. It was also found in that town in outdoor garbage pails. However, careful observation and extensive trapping near the mess-hall at the Wildlife Laboratory yielded no specimens. Nor was it to be found in the grocery store in Moran where shipments of bananas, other fruit and vegetables were frequently received. Careful inspection of garbage pails behind the Teton Lodge restaurant in Moran and of the Moran garbage dump yielded no specimens. In the summer of 1948 a colony of *D. melanogaster* had not become established in and around Moran by the last of August, though there was an abundant food supply. Seldom will a human community of this size be found without its accompanying colony of this fly. Almost certainly the species cannot over-winter outdoors in the Jackson Hole region. Probably some summers the species does become established as a temporary colony at Moran.

OTHER SPECIES RECORDED FOR WYOMING

Mainland and Wheeler (see Table 1) record *Drosophila busckii, funebris,* and *hydei* in considerable numbers from Wyoming. These are all introduced species, cosmopolitan in cities and towns. They were not observed in Jackson though one or more of them might be expected there. Extensive collecting in any of the larger towns of the state would probably disclose these species and *D. immigrans* and *D. repleta,* also cosmopolitan associates of man. Whether any of these five species occurs in a small community such as Moran will depend on their accidental introduction. The summer food supply is adequate, but the species would almost certainly die out in winter.

CONCLUSIONS

The small number of native species of *Drosophila,* five in all, is no doubt correlated with the high altitude and the northern latitude. In Texas where Dr. J. T. Patterson and his co-workers have made very extensive collections, 47 species have been recorded. A number of these, however, are introduced and not native. In Ohio rather extensive collecting has yielded 28 species, of which seven are introduced and the rest native. In Tennessee, which almost certainly has as many native species as Ohio, the author and Dr. Harrison Stalker found only one native species, *D. athabasca,* at the summit of Klingman's Dome, elevation about 6500 feet. Collecting in the High Sierras Dr. Th. Dobzhansky has often found only one or two species.

In our work in the Jackson Hole area we have attempted to collect in a variety of habitats and at the same time to secure a fairly adequate sample from each habitat. On the basis of our collection records for August 1948, *Drosophila suboccidentalis* is the dominant species in this region. It was found abundant in forests at lower elevations and in smaller numbers at higher elevations up to almost 10,000 feet. In marshy areas *Drosophila subquinaria* tends to replace *D. suboccidentalis,* and is also found in small numbers in forests far from any marsh, pond, or stream. *Drosophila montana* is found

in considerable numbers near marshes, ponds, and streams. It was completely absent from collections made in woods far from water. *Drosophila athabasca* and *D. pseudoobscura* were taken in numbers too small to draw any conclusions as to their ecological distribution in the region. Certainly in comparison to much of their geographical range they are rare in the Jackson Hole area. If other native species occur in the region they are extremely rare or not attracted to traps baited with yeasted banana.

TABLE 1.—Collection records of species of the genus *Drosophila* made by G. B. Mainland and M. R. Wheeler in July 1941 in Wyoming. (Taken from Patterson, 1943.)

Species	Numbers
D. suboccidentalis	978
D. athabasca	342
D. melanogaster	281
D. hydei	291
D. montana	256
D. funebris	77
D. subquinaria	66
D. pseudoobscura	63
D. busckii	32
Total	2,386

TABLE 2.—Collection records of species of the genus Drosophila in the Jackson Hole area, August 1948. W. P. Spencer and Rada Demerec.

Species	Collecting Areas										
	1	2	3	4	5	6	7	8	9	10	Totals
D. suboccidentalis ♂ ♂	261	61	468	578	310	331	1	29	14	1	2054
D. suboccidentalis ♀ ♀	239	85	479	541	265	343	3	25	14	0	1994
D. subquinaria ♂ ♂	70	3	23	61	89	31	0	89	22	0	388
D. subquinaria ♀ ♀	84	7	32	83	107	35	0	94	34	0	476
D. montana ♂ ♂	20	0	0	3	59	21	0	23	1	0	127
D. montana ♀ ♀	22	0	0	3	99	54	0	18	0	0	196
D. athabasca ♂ ♂	3	0	1	2	0	2	0	4	5	0	17
D. athabasca ♀ ♀	9	0	1	1	1	3	0	1	6	0	22
D. pseudoobscura ♂ ♂	0	0	0	1	0	1	0	0	0	0	2
D. pseudoobscura ♀ ♀	0	0	0	0	0	0	0	0	0	0	0
D. melanogaster ♂ ♂	0	0	0	0	0	0	0	0	0	2	2
D. melanogaster ♀ ♀	0	0	0	0	0	0	0	0	0	3	3
Totals	708	156	1004	1273	930	821	4	283	96	6	5281

Note: Collecting areas numbered in the table above are as follows: (1) Pacific Creek; (2) Summit Signal Mountain; (3) Half-way up Signal Mountain; (4) Base Signal Mountain; (5) Teton Glacier Trail-Marsh; (6) Teton Glacier Trail-Glacial Stream; (7) Teton Glacier Trail-Surprise Lake; (8) Lily Pond-Jackson Moran Road; (9) Vicinity of Wildlife Laboratory; (10) Grocery, Jackson, Wyoming. See text for details.

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Tanypodinae of Iowa (Diptera). III.

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The present paper is a continuation of our previous reports on Iowa species of the subfamily Tanypodinae (Hauber 1945; Hauber and Morrissey 1946). It is the object of this paper to list the species of the subfamily which we have not already reported, to record hitherto undescribed stages in the life histories of some of these midges, and to correct the misidentification of our earlier papers. The author wishes to thank Dr. U. A. Hauber for his aid in planning this paper and particularly for diagnosis of some of the difficult specimens.

The Genus PENTANEURA Philippi

Hauber (1945) reported twelve species of *Pentaneura* from Iowa. Examination of his specimens in the light of Johannsen's recent revision of this genus (Johannsen 1946) shows that some of the identifications were incorrect.

Pentaneura annulata (Say).—This species was reported as *Pentaneura monilis* in the 1945 report. Malloch (1915) confused *P. annulata* and *P. monilis* and as our identifications were based on his keys we made the same error. All our specimens labelled "*monilis*" are really *annulata*. We have no true *monilis*. This species is common at Davenport and Okoboji from June to September.

Pentaneura planensis Johannsen.—It seems certain that the specimens Hauber referred to as *P. nigropunctata* are of this species. In addition we have five new specimens taken between April 25 and August 15. These vary somewhat in paleness and in three of them the brown fascia are united to form a pale brown streak along the dorsum of the abdomen. In all other respects they agree with Johannsen's description of the species. One male in our collection emerged from decayed vegetable material collected in 18 inches of water in a small pond. The pupal cast of this specimen is 4.0 mm in length. The respiratory organ (Fig. 1) is without diverticula and 0.27 mm long. The length of the anal fin (Fig. 2) is 0.45 mm and it is 0.20 mm in width. The cast is clear and with conspicuous shagreen.

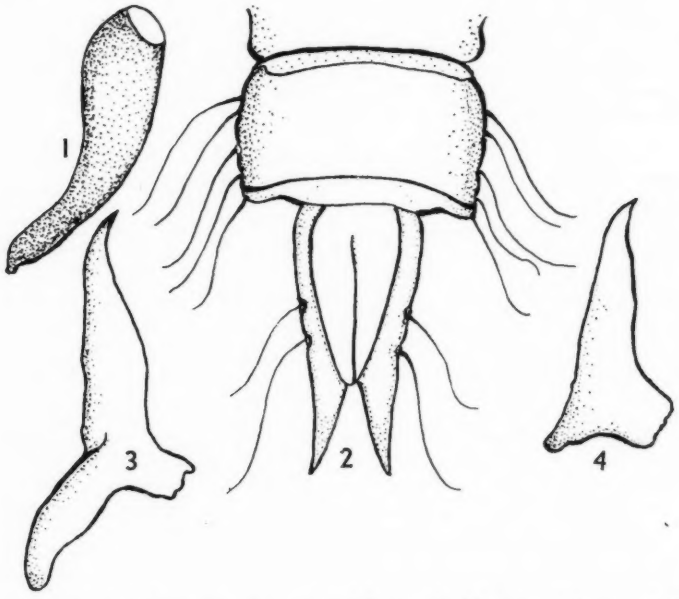
Anatopynia (*Macropelopia*) *hirtipennis* (Loew).—We have reared many adults of this species. The pupal casts are similar in every character except size to those of *Anatopynia fastuosa* as described by Johannsen (1937). The exuviae of *A. hirtipennis* average 7.5 mm in length; those of *A. fastuosa* are 4.0 mm. The pupal cast of *hirtipennis* is very yellow. This species is rather common at Davenport.

Anatopynia (*Psectrotanypus*) *dyari* Coquillet.—This species is fairly common from mid-April to November. The larvae are found in ponds and slow creeks.

Coelotanypus concinnus (Coquillet).—We have many adult specimens from Davenport and Okoboji, July 12 to August 15. Larvae and pupae were collected from a sand bottom in 40 feet of water at Lake Okoboji. One of our pupal specimens has an unusual tuft of filaments attached near the base of the respiratory organ. There are apparently seven filaments in this tuft which is about twice the length of the respiratory organ.

Coelotanypus scapularis (Loew).—Adults are common both at Davenport and Okoboji from June 15 to August 15. We have not found the immature stages but the adults are particularly common around the deeper parts of the Mississippi River where they may breed.

Clinotanypus thoracicus (Loew).—Larvae of this species were taken at Crystal Lake near Davenport, November 3, and emerged during January. The larval stages correspond with Johannsen's *Clinotanypus* Species A in size and in the shape of the palpus and lingua (Johannsen 1937). However, the ratio of the terminal antennal segment to the remainder of the antenna is about 1:16 in our specimens as compared with Johannsen's figure of 1:8. Shrinkage in our specimens may account for this difference. The larvae average 14.0 mm in length.



Figs. 1-4.—1, 2. Respiratory organ and anal fin (resp.) of *Pentaneura planensis*. 3, 4. Dististyle of *Procladius culiciformis* type and *P. choreus* type (resp.).

Three pupal casts we have assigned to this species average 7.5 mm in length. *Clinotanypus nervosus* as described by Goetghebuer (1927) is 11.0 mm long but his drawing of the anal fin and eighth segment of *C. nervosus* is the same as ours. Johannsen's figure and description of the pupa of *C. pinguis* (Loew) fit our specimens closely.

Tanypus stellatus Coquillet.—Adults were collected from July 1 to August 25 at Davenport and Okoboji. The immature stages were found in the shallow water of lakes and ponds. Eight pupal casts presumably of *T. stellatus* were collected at Credit Island lagoon, Davenport, September 11. Of these eight casts, all have six filaments on the seventh segment. On the eighth segment, five have 5 filaments each, and three have 10 filaments. Johannsen's description of the pupa of this species (1937) mentions only 5 filaments on the eighth segment. Since these casts are similar in all other respects to typical *stellatus* they may be only a variety of that species.

Tanypus punctipennis Meigen.—Adults have been taken at Okoboji and Davenport from April 20 to October 7. It is not common at either place. Pupae have been found in shallow ponds at Davenport.

Procladius culiciformis (Linn.) and *Procladius choreus* (Meigen).—There has been some question regarding the specific identity of these two forms. Edwards (1929) considers *P. culiciformis* perhaps only a variety of *choreus* and notes no difference in the hypopygia. Johannsen (1905) calls attention to differences in the coloration of the wings and abdomen. Malloch (1915) figures conspicuously different hypopygia for the two forms and says that *choreus* has the fore tarsi bearded.

In our Iowa specimens there is a continuous gradation in color between the extremes described by Johannsen. The smoky or hyaline quality of the wings varies and is of no diagnostic value. The hypopygia, however, are of two very distinct types. In one type the dististyle is conspicuously two lobed and the lobes are nearly equal (Fig. 3). The fore tarsi of the males of this group are never bearded. This form corresponds with Malloch's *P. culiciformis*. In the other type the dististyle is also two lobed but the lobes are not equal; the posterior lobe is not at all produced (Fig. 4). Four out of ten of our male specimens in this group have the fore tarsi bearded. This form resembles Malloch's *P. choreus*. The character of the dististyle seems constant and we have observed no intergradation in the two types.

Our *choreus* are all from Okoboji; our *culiciformis* are from Davenport. Many specimens of the latter have been reared from plant material collected in shallow ponds. A few adult *P. choreus* were reared from material collected in 25 to 30 feet of water at Okoboji. The pupae of the two species seem identical.

Procladius bellus (Loew).—This species is very common at Davenport and Okoboji from April through September. Adults have been reared from algal mats found in shallow ponds.

Procladius sp.?.—A pupal cast collected at Crystal Lake near Davenport,

April 30, 1941 resembles *Procladius* (*Psilotanypus*) *adumbratus* Johannsen. The exuvia is 5.1 mm in length and is mottled brown in color. In all other respects it is like Johannsen's description (1937).

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Studies on the Biology of Some Percid Fishes From Western Pennsylvania

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Within recent years considerable work has been concentrated upon the study of the life histories of our larger percid fishes that provide both sport and food for man. The life histories of most of our smaller Percidae, the darters, are still not completely known. Several studies have revealed some of their spawning habits, such as those of Adams and Hankinson (1928), Atz (1940), Hankinson (1932), Jaffa (1917), Lake (1936), J. J. Petravicz (1936), W. P. Petravicz (1938), Reeves (1907), Reighard (1913) and Seal (1892). In this study we have attempted to make known several of the main features of the life history of three species of darters, mainly by scale analysis. These species, the variegated darter, *Poecilichthys variatus* (Kirtland), the eastern banded darter, *Poecilichthys zonalis zonalis* Cope, and the northern greenside darter, *Etheostoma blennoides blennoides* Rafinesque, are quite common in the upper Allegheny River system of western Pennsylvania. Their ranges are given by Hubbs and Black (1940: 7) and Hubbs and Lagler (1947: 88, 89). These darters have remained in such obscurity that even brief generalizations of their life histories are not available. Such discussions of *blennoides* by Evermann and Clark (1920: 440-442, colored plate) and Forbes and Richardson (1920: 292-294, colored plate) and of *zonalis* by Forbes and Richardson (1920: 304-306, fig. 73) are mainly descriptional. Their habitat and associates, abundance and density, sexual dimorphism, sex ratio, longevity and comparative rates of growth are discussed and tabulated, herein.

Material

Most of the darters used in this study were collected by the writers in the past two years. Over 2,000 specimens were collected for study, and of these, a total of 873 *zonalis*, 416 *variatus*, and 176 *blennoides* were specifically aged. A total of 1,336 specimens, including 809 *zonalis*, 372 *variatus* and 155 *blennoides* were taken from one riffle in French Creek at Carlton, Mercer County, Pennsylvania near the end of the growing season on October 5 and 8, 1947. These collections with another collection of 129 specimens of the three species made about 25 miles up-stream from Carlton in French Creek at Venango, Crawford County, Pennsylvania, on October 5, 1947, formed the most important material for growth study. Additional collections were made at these same localities on May 27 and July 15, 1948 and with several smaller collec-

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tions taken at various times throughout summer months from different localities in the Ohio River basin of western Pennsylvania, provided the necessary sequential size groups for age determination.

HABITAT

These darters are riffle inhabiting fishes, usually most common in clean water rivers of moderate size with a fairly rapid flow and the riffle bottom composed of rubble and gravel with some aquatic plant growth. This type of habitat appears typical for these species in the Ohio drainage basin of western Pennsylvania, as well as other areas of their ranges (Hubbs and Lagler, 1947: 88-89; Trautman, 1946: 37, 41). In French Creek at Carlton, Mercer County, where most of our specimens were taken the riffles are about 150-200 feet in width and about 75 feet long, with the bottom consisting chiefly of rubble, gravel and some sand. On October 5 and 8, 1947, the water depth at the crest of the riffle averaged about 2 feet. The water temperature at this time was 61° F. A fair growth of aquatic plants was present. The most common of these, other than filamentous algae, were water moss (*Fontinalis*), pondweeds (*Potamogeton*) and wild celery (*Vallisneria*). Deeper slack waters, from 4 to 8 feet in depth, with bottoms of sand, mud and boulders above and below this riffle are not inhabited by these darters, and serve as an ecological barrier that delimits the distribution of these species in the river.

Other bottom inhabiting riffle associates taken with *blennoides*, *variatus* and *zonalis* in French Creek at Carlton on October 5 and 8, 1947, were *Poecilichthys maculatus*, *Poecilichthys f. flabellaris*, *Poecilichthys c. caeruleus*, *Poecilichthys tippecanoe*, *Boleosoma n. nigrum*, *Hadropterus maculatus*, *Percina c. caprodes*, *Noturus flavus* and *Schilbeodes eleutherus*. Other species taken in the riffle were *Catostomus c. commersonii*, *Hypentelium nigricans*, *Moxostoma erythrurum*, *Moxostoma anisurum*, *Ameiurus natalis natalis*, *Notropis cornutus chrysocephalus*, *Notropis rubellus*, *Notropis photogenis*, *Notropis deliciosus stramineus*, *Nocomis micropogon*, *Campostoma a. anomalum*, *Erimystax dissimilis*, *Hyborhynchus notatus*, *Notemigonus crysoleucas auratus*, *Ambloplites r. rupestris* and *Micropterus d. dolomieu*.

At Venango, Crawford County, the riffle is about 150 to 200 feet in width but extends to a length of more than 300 feet. The bottom composition and plant life is fairly similar to the Carlton riffle except that more sand is present. Riffle associates taken in the fall, October 5, 1947, were quite similar to those just listed. In addition to those listed above as riffle bottom inhabiting forms, *Poecilichthys camurus*, *Hadropterus evides* and *Ammocrypta pellucida* were also taken. These bottom forms seem to be present in the riffles throughout the year, although certain species may have a preference for particular niches at various seasons (Raney and Lachner, 1939: 158). Riffle bottom associates in the spring (May 27, 1948) for these two localities were about the same as those presented for the fall. *Hadropterus macrocephalus*, and two species of lampreys, *Ichthyomyzon greeleyi* and *Ichthyomyzon bdellium* were additional species taken at Venango at this time. The occurrence of certain fishes in riffles, for example the cyprinids, may be quite variable in different seasons, such

as spring and summer, and is related to such activities as feeding and spawning, whereas, the seasonal occurrence of darters such as *P. zonalis*, *P. variatus*, *P. maculatus*, *P. camurus*, and *E. blennoides* is apparently quite constant. The three species included in this study seem to avoid the area just above the crest of the riffle, where *Boleosoma n. nigrum* and *Poecilichthys f. flabellaris* were taken. They seem also to avoid the deeper waters at the base of the riffle, where *Percina caprodes* may be taken near a submerged log or boulder. Near the shore line, where much vegetation was present and the water flow reduced, these darters were replaced by *Hadropterus maculatus*. When the shoreline or riffle was made up of sandy areas with little or no gravel, as at the Venango locality, *Ammocrypta pellucida* would be found. During summer and fall months the area of the riffles in which *zonalis*, *variatus* and *blennoides* seem commonly limited in French Creek is within several yards of the crest and base, and several yards from heavily vegetated sandy shores.

ABUNDANCE

The Carlton riffle was intensively seined for darters on October 5 and 8, 1947, to get some idea of their density and relative abundance, for they were known to be common in this riffle from previous seining. Of the darters listed above for this locality, *zonalis* was most abundant. A total of 809 specimens taken on these two days, represented about 56 per cent of the riffle darter population caught. Numbers and per cent of total population taken of other species of darters were: *variatus*, 372 specimens, 26 per cent; *blennoides*, 155 specimens, 10 per cent; *Hadropterus maculatus*, 47 specimens, 3 per cent; *Boleosoma n. nigrum*, 33 specimens, 2 per cent; *Poecilichthys f. flabellaris*, 21 specimens, 2 per cent; all other percid species listed above for this locality, less than 1 per cent. These large populations of *zonalis*, *variatus* and *blennoides* suggest that this riffle seems to provide abundantly the necessary ecological requirements.

Three methods were considered for use in determining these populations: the electric shocker, poison and intensive seining. The electric shocker method has not proved very efficient in the recovery of fingerling trout and darters in small rubble-gravel tributary streams in central Pennsylvania. Facilities for blocking the base of such a large riffle as that at Carlton would require rather elaborate construction. These were not available and would be necessary if poison or the electric shocker method were to be employed with success. Further, the recovery of these percid fishes from beneath the flat stones is extremely difficult using the shocker or poison method, for no air bladder is present and they easily become lodged. Thus these two methods were abandoned and the intensive seining method employed.

Using a net 20 feet long, 4 feet wide with 1/4 inch square mesh, heavily weighted, it required a total of about 8 to 9 hours intensive seining on October 5 and 8, to remove an estimated 80 to 85 per cent of the riffle population at Carlton. Four students assisted in this work. The riffle was seined systematically from its base to the crest and this operation was repeated several times. Several students manned the net in a down stream position while others would

turn over the slab rocks, rubble and gravel, and force the darters to swim into the net or allow the water to carry them there. An area of about 100 to 125 square feet would be covered with each seine haul. An average of about 10 darters of the three species was taken on each haul while working the riffle for the first trial. In some hauls over 30 juvenile and adult darters were caught. After repeated trials over the entire riffle, but a single juvenile or adult specimen could be taken, and upon continued seining, only occasionally did a haul yield an adult *variatus* or *blennoides*. Areas below the riffle as well as above the crest were seined. The differential yield in hauls after about 8 hours of seining over the entire area of the riffle made it possible to estimate that probably 90 per cent or more of the adult population of *zonalis*, *variatus* and *blennoides* had been removed, and about 80 to 90 per cent of the juveniles and young. Time did not permit us to mark large numbers of darters for recapture, and high waters interrupted our population studies during the spring months. Attempts were made to mark specimens on July 15, 1948 at Carlton, but only a few *zonalis* and *blennoides* were taken in 2 hours seining and no *variatus*.

It was estimated that the Carlton riffle consisted of an area of about 15,000 square feet during October 1947. The water was exceedingly low and the stream gradient is high enough to define the limits of the riffle clearly. About 1,500 darters of all species were removed at this time, and if we use a figure of about 85 per cent efficiency in capture, the riffle then contained about 1.725 darters, or an average of about one darter per 9 square feet. This would infer that these darters live within about 3 feet of one another, providing they have no gregarious habits. Should our estimated figure of 85 per cent efficiency of capture be too high, as we suspect, for the young and juvenile darters are more difficult to capture, then we might expect the range between darters to be a maximum of perhaps 2 feet or less.

The density and abundance of these percid fishes is of interest in that they may consume large numbers of aquatic insects. Fishery biologists have long employed the presence of large numbers of desirable aquatic insects as one index to water suitability for certain species of game fishes. Frequently little or no attempt is made to determine the abundance of non-game species such as the many forage cyprinid fishes. Correlated studies between forage fish, fish food and environment have received too little attention.

SEXUAL DIMORPHISM

Sexual dimorphism is greatly developed in many of the darters. The body and fin colors are highly developed, particularly during the breeding season, not only in *zonalis*, *blennoides* and *variatus* but on such other associates as *P. tippecanoe*, *P. maculatus* and *P. camurus*. The males retain the brighter colors throughout the year. The colors of the adult *zonalis* and *blennoides* are discussed in part by Forbes and Richardson (1920: 293, 304-305) and Evermann and Clark (1920: 441-442) and the bright colors of *variatus*, varying from yellow-orange to bluish-purple, by Jordan and Evermann (1896: 1070). Some of the more distinct sexual dimorphic characteristics of the three species are listed below.

Character	Males	Females
1. Anal papillae, in adults	Smaller (x)	Larger, at least 2 x
2. Size (body)	Larger	Smaller
3. Growth rate	More rapid	Less rapid
4. Color of body and fins in adult	Brighter, more pigmented	Paler, less pigmented
blennoides	Lateral green markings tending to form broad vertical bands	Lateral green markings pale and Y-shaped
zonalis	Vertical green bands broader and encircle body	Vertical green bands narrower, and generally do not encircle body
variatus	Body colors varied and more profuse	Body colors less varied and less profuse
5. Size of fins in adults		
pectoral,	Usually smaller in length, 3.9-4.8 in standard length	Usually larger (3.3-4.2)
blennoides	Averages smaller (4.1-5.6)	Averages larger (3.7-4.9)
zonalis	About the same (3.2-4.1)	About the same (3.4-4.0)
variatus	About the same	About the same
pelvic		
anal,	Usually larger (3.9-4.2)	Usually smaller (4.1-4.9)
blennoides	About the same (4.2-5.3)	About the same (4.3-5.2)
zonalis	Larger (3.5-3.9)	Smaller (4.1-4.6)
variatus		
1st dorsal	Usually larger (3.0-3.2)	Usually smaller (3.1-3.5)
blennoides	Usually larger (3.0-3.6)	Usually smaller (3.4-3.7)
zonalis	Averages larger (3.0-3.4)	Averages smaller (3.2-3.4)
variatus		
2nd dorsal	Usually larger (3.0-3.5)	Usually smaller (3.5-3.8)
blennoides	Usually larger (3.4-3.7)	Usually smaller (3.5-4.2)
zonalis	Almost always larger (3.0-3.4)	Almost always smaller (3.4-4.0)
variatus		

SEX RATIO

The presence of more males than females appears characteristic in the three species, based on specimens from French Creek, Pennsylvania. The sex ratio at various ages with chi-square and probability values of the three species are presented in Table 1. In collections made at various times of the year Raney and Lachner (1939: 163) found a sex ratio of 1.8:1 (males : females) in *Poecilichthys maculatus,* while Lake (1936: 828) reported a ratio of 1:2.3 (M : F) for *Poecilichthys f. flabellaris.* In one large collection of 1,000 speci-

mens of *Poecilichthys exilis*, all believed to be in their first year of life, Gosline (1947: 4) found a ratio of 495 : 505 (M : F). Studies by Raney and Lachner (1943: 233) of *Boleosoma nigrum olmstedi* show the sex ratio to vary considerably in different localities.

Of interest in this study is the tendency, in all three species, to an increased number of males with increase in age (Table 1). Collections of *zonalis* and *variatus* taken at the end of their first summer of life showed no significant departure from a 1 to 1 ratio (see probability value, Table 1), although these collections were quite large. Other than the collections of *zonalis* and *variatus* for the first year group, all other collections for the various year groups show a significant departure from a 1 to 1 ratio, except where too few specimens were available (as in *variatus*, 3rd summer, 16 specimens, etc.). It is not known whether the sex ratio varies with increased age or if such conditions represent variabilities in the same population in different years. However, the data are of interest in view of the possible spawning habits of these species, of which so little has been reported.

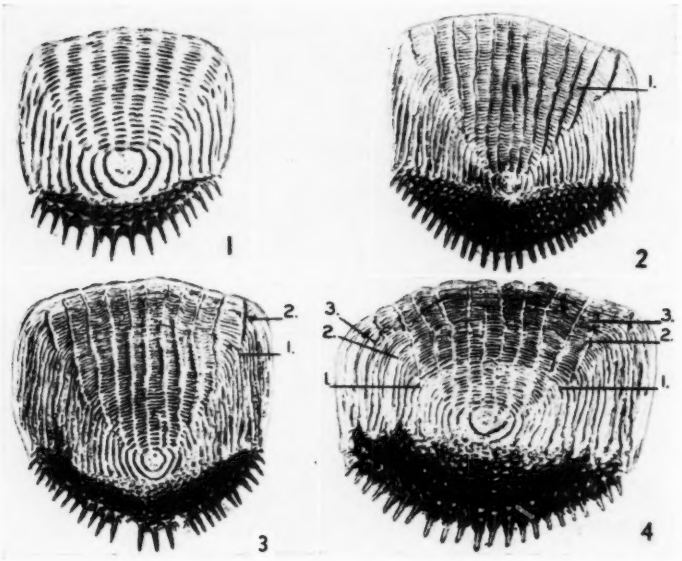
DETERMINATION OF AGE

Scales were removed from the mid-side of the body, usually above the lateral line, cleaned and mounted on a microscope slide in glycerine jelly. When the annulus formation was studied and the specific age for a number of

TABLE 1.—The probability for values of chi-square that a significant departure from a 1 to 1 sex ratio occurred in specimens of three species of darters of various age groups from French Creek, Pennsylvania, taken October 5 and 8, 1947. (For method of calculation of chi-square, see Snedecor, 1946.)

Species	Age	Number of Specimens, Males-Females	Sex Ratio M-F	Chi-Square	Probability
P. zonalis	0	138:115	1.2:1	2.08	.20-.10
	1	230:126	1.8:1	30.38	< .001
	2	173:70	2.5:1	41.92	< .001
	3	13:8	1.6:1	1.18	.30-.20
P. variatus	0	99:77	1.3:1	2.76	.10-.05
	1	81:55	1.5:1	5.00	.05-.02
	2	52:36	1.4:1	2.90	.10-.05
	3	10:6	1.8:1	1.00	.30
E. blennoides	0	31:17	1.8:1	4.10	.05-.02
	1	16:8	2.0:1	2.68	.10
	2	69:19	3.5:1	28.40	< .001
	3	13:2	6.5:1	8.10	.01-.001

specimens established, the practice of mounting scales was discontinued and age determinations were made while the scales were in the water of a watch glass. Binocular microscopes of various magnifications were used. One junior author always compared the age determination of a specific specimen with that of the senior author, and after considerable practice, almost complete agreement resulted. In a few scales disagreement of age determination resulted in the older specimens where considerable regeneration had occurred, or where growth was greatly reduced the last summer of life and the last annulus was not readily perceptible.



Figs. 1-4.—1. Scale of a female northern greenside darter, *Etheostoma blennoides blennoides*, 40 mm in standard length, collected October 8, 1947 from French Creek, Allegheny River System, at Carlton, Mercer County, Pennsylvania. This specimen had lived through its first summer, and no annulus had formed; 2. Scale of male variegated darter *Poecilichthys variatus*, 55 mm in standard length, collected October 8, 1947 from French Creek at Carlton, Pennsylvania, showing one annulus; 3. Scale from a female eastern banded darter, *Poecilichthys zonalis zonalis*, 44 mm in standard length, collected October 8, 1947 from French Creek at Carlton, Pennsylvania. This specimen had completed its third summer. Two annuli are designated by numerals. Note the great growth of the first summer compared to the third summer, as indicated by linear scale dimensions; 4. Scale of a male *blennoides*, 77 mm in standard length, collected on October 5, 1947 from French Creek at Carlton, Pennsylvania. This specimen had lived through four summers; three annuli are indicated. Characteristic of the three darters studied was the great retardation in growth after the second summer.

The scale method has been employed in the study of growth of several percid fishes, such as the pike-perches, *Stizostedion,* yellow perch, *Perca flavescens,* and the johnny darters, *Boleosoma nigrum olmstedi* and *Boleosoma longimanum* (Raney and Lachner, 1943). The formation of the annulus and scale growth is, in many respects, similar to that of the johnny darters. In specimens of *zonalis, variatus* and *blennoides* collected from French Creek during the spring and early summer of 1948, it was determined that the annulus is generally formed in latter May and June. In specimens from French Creek collected May 27, 1948, one-year-old *zonalis* and *variatus* had the first annulus

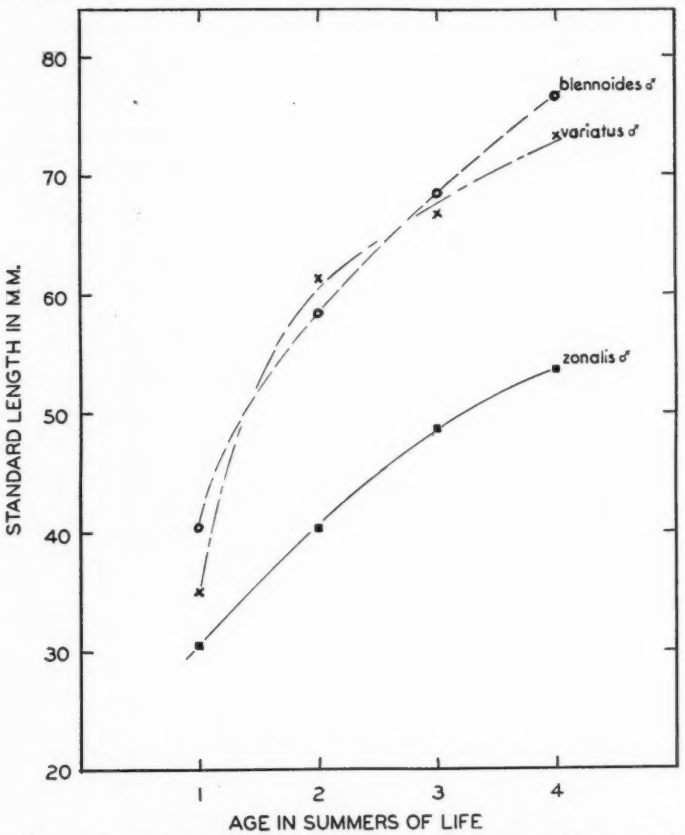


Fig. 5.—Curves showing comparative growth rates of male *Poecilichthys z. zonalis, Poecilichthys variatus* and *Etheostoma b. blennoides,* collected on October 5 and 8, 1947 from French Creek, Allegheny River system, at Carlton and Venango, Pennsylvania. The curves were drawn through the means of the respective age groups and were based on collections of 554 specimens of *zonalis,* 242 *variatus* and 129 *blennodies.*

appearing just 2 to 3 cerculi from the scales' margin, and it was not formed in older specimens. At this time, specimens of all ages of *blennoides* showed no annulus. It is of interest to note in these collections of several hundred adults of the three species that all *variatus* of both sexes had spawned; only about half of the *blennoides* were spent and practically all *zonalis* had not spawned. The water temperature was about 63° F. Thus, the annulus had formed in young *zonalis* before the spawning period. In the adults of the three species the annulus appears to be formed coincident with the breeding period. It is interpreted as the mark where growth ceased during winter months and began again in the spring. The breeding activities of the adults appear to retard its formation, for they probably do not grow much until after this period. By mid-July scale growth of the three species of darters in their second summer of life is considerably more than in the older adults. Only a few *zonalis* specimens appeared mature at one year of age; all others were mature at two years of age. Mature *variatus* and *blennoides* were found only among specimens two years of age or more.

Unlike the johnny darter, the annulus in the three species studied is quite visible in the lateral as well as the anterior fields. Scales of these species are figured (1 to 4) and annuli are indicated by Arabic numerals. It is not especially difficult to follow the annulus from the anterior to the posterior field in microscopic examination. The most rapid growth takes place in the early summer months causing the cerculi to be more widely spaced at this time than in late summer (Figs. 1 and 2). This forms a sort of banding of the cerculi on the scale, noticeable especially during the first two years but is not nearly so accentuated as in *Bolesoma nigrum olmstedi* (Raney and Lachner, 1943: 230, fig. 1). The linear distance from the scale focus to the first and second annulus is somewhat descriptive of the very rapid growth during the first and second years of life (Figs. 2 and 3). Some scales of *variatus* showed a checkmark which may have represented a slowing down in growth during the midsummer. When present on a scale it was most evident in the anterior field where the cerculi were very closely grouped. The sparse rainfall over most of eastern United States during mid summer and fall of 1947 was evident in French Creek by the low water flow. These conditions with reported warmer water temperatures may have indirectly accounted for these marks. They were not present on the scales of *zonalis* or *blennoides*.

LONGEVITY

The age of 873 specimens of *Poecilichthys z. zonalis*, 416 *Poecilichthys variatus* and 176 *Etheostoma b. blennoides* was determined and the results summarized in Tables 2 to 4. Growth curves for the three species with sexes separated are presented in figures 5 and 6. The age-frequency distributions are portrayed graphically in figure 7 for *zonalis*, figure 8 for *variatus* and figure 9, *blennoides*. These data indicate these darters to be relatively short-lived. Only 13 males in a collection of 554 *zonalis* examined, and 8 females in 319 had survived the fourth summer (Table 2), representing 2.3 per cent of the male population and 2.5 per cent of the females sampled on October 5 and 8,

TABLE 2.—Length frequencies for each age group of 873 specimens of *Poecilichthys zonalis zonalis* from French Creek, Allegheny River system, at Carlton and Venango, Pennsylvania, on October 5 and 8, 1947.

Standard length in millimeters	SUMMERS OF LIFE								Totals for all age groups		
	1		2		3		4				Sexes Combined
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
20		1							–	1	1
22		–							–	–	–
24	5	6							5	6	11
26	16	9							16	9	25
28	38	45							38	45	83
30	26	30							26	30	56
32	32	18		1					32	19	51
34	13	4	5	18					18	22	40
36	8	2	29	32					37	34	71
38			72	40	1	3			73	43	116
40			59	25	4	9			63	34	97
42			36	7	4	26		2	40	35	75
44			20	3	19	19		–	39	22	61
46			8		31	11	1	5	40	16	56
48			1		44	2	1	1	46	3	49
50					32		1		33	–	33
52					29		2		31	–	31
54					8		5		13	–	13
56					1		2		3	–	3
58							–		–	–	–
60							–		–	–	–
62							1		1	–	1
Number of specimens	138	115	230	126	173	70	13	8	554	319	873
Mean	30.5	29.1	40.2	38.1	48.7	43.4	53.7	45.7	–	–	–
Standard Deviation	2.96	2.54	2.73	2.44	3.28	2.24	3.80	–	–	–	–

1947 from French Creek. In *variatus*, 4.1 per cent of the males and 3.4 per cent of the females in 416 specimens from French Creek survived the fourth summer (Table 3), while in *blennoides* 1 female and no males in a collection of 176 specimens (Table 4) had survived the fifth summer. Only two females (4.3 per cent) and 13 males (10 per cent) of *blennoides* were taken in their fourth summer of life. From these data the darters appear quite similar in age attained, one female (*blennoides*) having survived an age beyond the fourth year in all three species.

GROWTH RATE

The growth data for *zonalis* are given in Tables 2 and 5 and figs. 5 to 7. Most of the growth occurred during the first summer of life, the males having attained a mean standard length of 30.5 mm. at the end of the first summer (October 8) while the females reached a length of 29.1 mm. These lengths

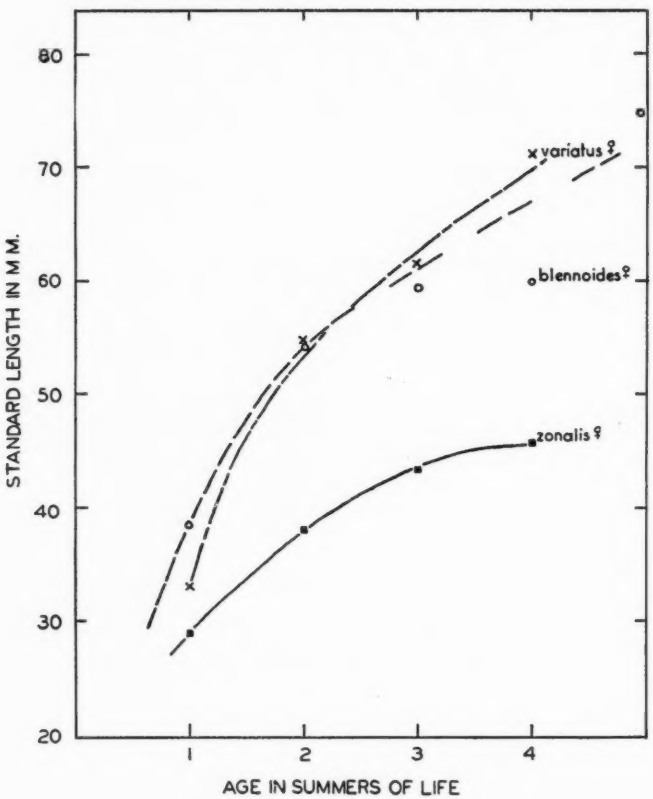


Fig. 6.—Curves showing the comparative growth rates of female *zonalis*, *variatus* and *blennoides* collected on October 5 and 8, 1947. These specimens were taken from the same locality as the males (fig. 5), and the curves were drawn similarly. The curves were based on collections of 319 specimens of *zonalis*, 174 *variatus* and 47 *blennoides*. Only two specimens of *blennoides* were taken at the end of their fourth summer and one at the end of the fifth year. The nature of this curve is not well founded for these years and is represented as an interrupted broken line.

TABLE 3.—Length frequencies for each age group of 416 specimens of *Poecilichthys variatus* from French Creek, Allegheny River system, at Carlton and Venango, Pennsylvania, on October 5 and 8, 1947.

Standard length in millimeters	Summers of Life								Totals for all age groups		
	1		2		3		4				Sexes combined
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
24		1							–	1	1
26	1	1							1	1	2
28	6	4							6	4	10
30	6	15							6	15	21
32	13	25							13	25	38
34	31	15							31	15	46
36	21	11							21	11	32
38	14	4							14	4	18
40	7	1							7	1	8
42									–	–	–
44				1					–	1	1
46				–					–	–	–
48				–					–	–	–
50				6					–	6	6
52			1	10					1	10	11
54			1	15		1			1	16	17
56			7	9		3			7	12	19
58			11	12		6			11	18	29
60			23	2	2	11			25	13	38
62			17		5	3			22	3	25
64			16		11	6			27	6	33
66			5		15	4			20	4	24
68					11	2		1	11	3	14
70					5		3	3	8	3	11
72					2		3	1	5	1	6
74					1		2	1	3	1	4
76							2		2	–	2
Number of Specimens	99	77	81	55	52	36	10	6	242	174	416
Mean	35.0	33.1	61.3	55.0	66.7	61.6	73.1	71.2	–	–	–
Standard Deviation	3.06	2.88	2.96	3.10	2.94	3.50	–	–	–	–	–

represent about 57.0 per cent (males) and 63.6 per cent (females) of the mean standard lengths attained at the end of four summers of life. The males grow more rapidly than the females, and differences in length attained by the sexes of the same age are statistically significant at the end of the first summer

(Table 5). The rapid growth of *zonalis* during the first summer may be associated with early maturity, for some one-year-old specimens were found mature during late May. All *zonalis* are mature and spawn when two years of age. Considerable growth variation occurred within each age group for each sex (Table 2, fig. 7) and should a length-frequency curve be constructed from the data in Table 2, great overlap would occur between specimens of different ages. Judgments of age from length-frequency curves are quite erroneous in this species. The largest male *zonalis* captured had completed its fourth summer and had attained a length of 62 mm. in standard length (October 8) while the largest female was 48 mm. and had completed its fourth summer. The males attained a mean standard length of 30.5 mm. (range 24 to 36 mm.), 40.2 mm. (34 to 48 mm.), 48.7 mm. (38 to 56 mm.) and 53.7 mm. (46 to 62 mm.) at the end of their first, second, third and fourth summer's growth respectively. Females reached a mean standard length of 29.1 mm. (20 to 36 mm.), 38.1 mm. (32 to 44 mm.), 43.4 mm. (38 to 48 mm.) and 45.7 mm. (42 to 48 mm.) at the end of the same growth periods. The low values obtained for the standard deviation of these means (Table 2) as well as the highly significant values computed for the comparison of the means between sexes of the same age (Table 5) suggest the adequacy of the sample and the usefulness of the large numbers of specimens aged.

The growth data for *variatus* are presented in Tables 3 and 5 and figs. 5, 6 and 8. As in *zonalis* the males grow more rapidly than the females, and this growth difference is significant at the end of the first summer of life (Table

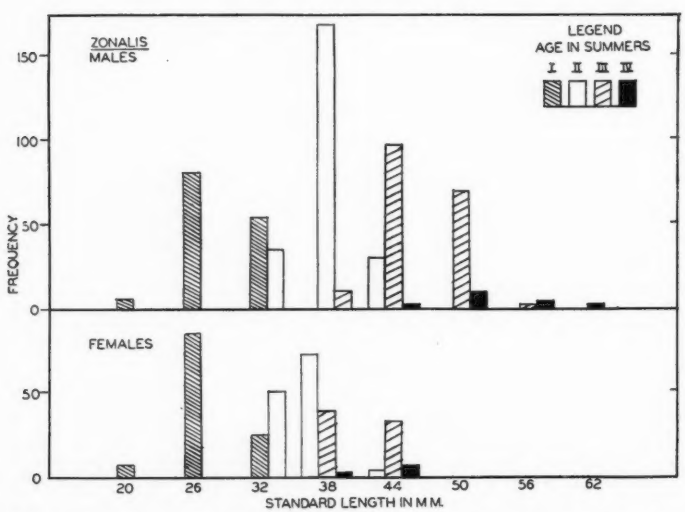


Fig. 7.—Age-frequency distribution of 873 *Poecilichthys zonalis zonalis*, collected October 5 and 8, 1947 from French Creek, Allegheny River system, Pennsylvania.

TABLE 4.—Length frequencies for each age group of 176 specimens of *Etheostoma blennoides blennoides* from French Creek, Allegheny River system at Carlton and Venango, Pennsylvania on October 5 and 8, 1947.

Standard length in millimeters	Summers of Life									Totals for all age groups		
	1		2		3		4		5			Sexes Combined
	♂	♀	♂	♀	♂	♀	♂	♀	♀	♂	♀	
34	1	1								1	1	2
36	5	5								5	5	10
38	6	6								6	6	12
40	11	4								11	4	15
42	3	1								3	1	4
44	3									3	–	3
46	2									2	–	2
48										–	–	–
50										–	–	–
52			1	2						1	2	3
54			1	5		1				1	6	7
56			5	1		3				5	4	9
58			2			6				2	6	8
60			7		2	5		2		9	7	16
62					3	3				3	3	6
64					13	1				13	1	14
66					6					6	–	6
68					20					20	–	20
70					12					12	–	12
72					9					9	–	9
74					4		5		1	9	1	10
76							5			5	–	5
78							2			2	–	2
80							–			–	–	–
82							1			1	–	1
Number of Specimens	31	17	16	8	69	19	13	2	1	129	47	176
Mean	40.3	38.4	58.3	54.2	68.4	59.5	76.5	60.0	–	–	–	–
Standard Deviation	2.94	1.98	2.38	1.18	3.02	2.46	2.2	–	–	–	–	–

5). Unlike *zonalis*, *variatus* increased in length about equally the first two summers of life, and thereafter growth was greatly reduced. No specimens of *variatus* were found mature when one year old. All specimens found to be two years of age were mature, at which time they all probably spawn for the first time. The rate of growth was so rapid that no overlap occurred in length-frequency distribution within sexes of the first and second year age groups.

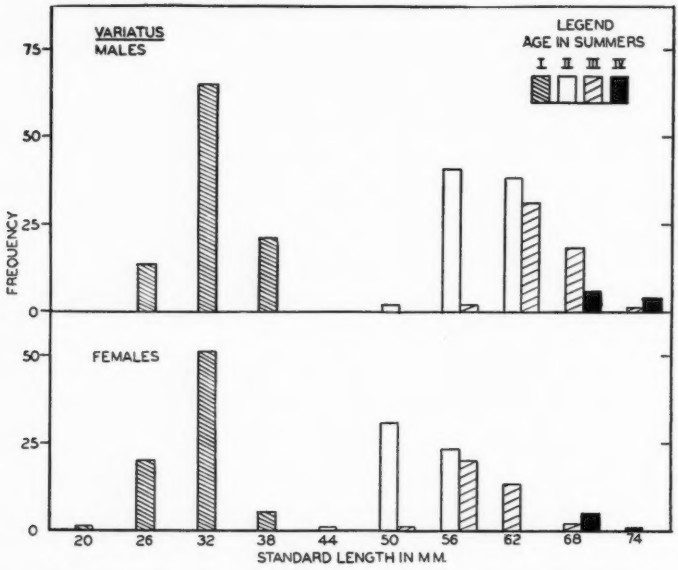


Fig. 8.—Age-frequency distribution of 416 *Poecilichthys variatus* collected October 5 and 8, 1947 from French Creek, Allegheny River system, Pennsylvania.

However, growth is greatly reduced during the third summer, and much overlap occurred in age-frequency distributions after two years of age (fig. 8). The largest male *variatus* taken was 76 mm. in standard length and had lived through its fourth summer (October 8) while the largest female was 74 mm. and had attained the same age. The males reached a mean standard length of 35.0 mm. (26 to 40 mm.), 61.3 mm. (52 to 66 mm.), 66.7 mm. (60 to 74 mm.) and 73.1 mm (70 to 76 mm.) at the end of their first, second, third and fourth summer's growth respectively. Females attained a length of 33.1 mm. (24 to 40 mm.), 55.0 mm. (44 to 60 mm.), 61.6 mm. (54 to 68 mm.) and 71.2 mm. (68 to 74 mm.) at the end of the same growth periods.

The data for growth of *blennoides* are given in Tables 4 and 5 and figs. 5, 6 and 9. The males, as in *zonalis* and *variatus*, grew more rapidly than the females, statistically significant at the end of the first summer of life. The males reached a mean standard length of 40.3 mm. (34 to 46 mm.), 58.3 mm. (52 to 60 mm.), 68.4 mm. (60 to 74 mm.) and 76.5 mm. (74 to 82 mm.) at the end of their first, second, third and fourth summers. Females attained a length of 38.4 mm. (34 to 42 mm.), 54.2 mm (52 to 56 mm.), 59.5 mm. (54 to 64 mm.) and 60.0 mm. at the end of similar growth periods. The rate of growth during the first two summers of life was most rapid, the males attaining at this age 76.3 per cent of their mean length at the end of four summers while

TABLE 5.—Values for the comparison of the means between sexes for various age groups of three species of darters from French Creek, Pennsylvania, collected October 5 and 8, 1947. A value exceeding 2 (.05 level of significance) suggests a real growth difference between sexes of the same age. Statistical methods advanced by Simpson and Roe (1939: 192-197) were followed.

Species		SUMMERS OF LIFE							
		1		2		3		4	
		♂	♀	♂	♀	♂	♀	♂	♀
P. zonalis	No. of Specimens	138	115	230	126	173	70	13	8
	Mean	30.5	29.1	40.2	38.1	48.7	43.4	53.7	45.7
	Value-Comparison of means	(4.12)		(6.93)		(12.55)		(5.23)	
P. variatus		99	77	81	55	52	36	10	6
		35.0	33.1	61.3	55.0	66.7	61.6	73.1	71.2
		(4.14)		(11.95)		(7.2)		(1.62)	
E. blennoides		31	17	16	8	69	19	13	2
		40.3	38.4	58.3	54.2	68.4	59.5	76.5	60.0
		(2.35)		(3.87)		(10.72)		–	

the females had attained 90.2 per cent of their length. The greenside darter spawns for the first time when two years old. Ripe and spent specimens were collected in French Creek on May 27, 1948. No specimens one year of age were found to be mature. As in *variatus*, the retardation of growth during the third year of life is undoubtedly associated with maturity and spawning activities. Variations of growth between sexes of the same age and within sexes of different ages resembled those of the variegated darter (fig. 9). The largest male, four summers in age, reached a standard length of 82 mm., while the largest female was 75 mm. and was captured at the end of its fifth summer.

The comparative growth rates of the three species are portrayed graphically for the males (fig. 5) and females (fig. 6). The northern greenside darter attained the largest size, grew most rapidly, especially during the first year of life, and reached the oldest age.

Practically no information is available concerning the breeding activities of these darters. In many other percid fishes in which the males exceed the females in size, territory guarding or egg guarding is exhibited by the males (Raney and Lachner, 1943: 236-237). In *Boleosoma, Poecilichthys f. flabellaris, Poecilichthys caeruleus,* and *Poecilichthys maculatus* a single male either guards the eggs or nest territory. In the nest building Cyprinidae such as *Nocomis, Semotilus a. atromaculatus, Semotilus corporalis,* etc., the males are likewise larger than the females. The tendency for the males to exceed the females in numbers, such as in *variatus, zonalis* and *blennoides,* is not consistent in nest guarding percid fishes where the spawning habits are known. Lake (1936: 828) reported more than twice as many female *Poecilichthys f. flabellaris* than males whereas Raney and Lachner (1939: 163) found a 1.8:1 ratio, males to females, in *Poecilichthys maculatus.*

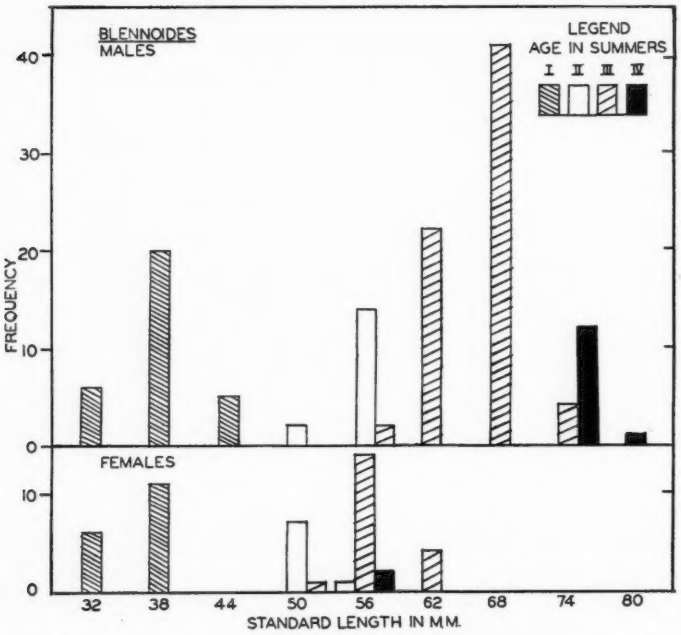


Fig. 9.—Age-frequency distribution of 176 *Etheostoma blennoides blennoides* collected October 5 and 8, 1947 from French Creek, Allegheny River system, Pennsylvania. Interesting is the large population of males in the third summer of life.

SUMMARY

1. The field observations and material for this study were taken from the Ohio drainage basin of western Pennsylvania, the collecting limited chiefly to French Creek, Allegheny River system.

2. All three species of small percid fishes studied, the eastern banded darter, *Poecilichthys zonalis zonalis*, the variegated darter, *Poecilichthys variatus* and the northern greenside darter, *Etheostoma blennoides blennoides*, normally inhabit certain riffle sites during the summer and fall months. Their habitats are compared with those of other percid associates as *Boleosoma nigrum olmstedi, Poecilichthys f. flabellaris, Percina caprodes, Hadropterus maculatus*, and *Ammocrypta pellucida*. Their riffle associates are listed.

3. French Creek supports a relatively abundant darter population; 1,336 specimens of the three species were taken on October 5, and 8, 1947 in one riffle at Carlton, Pennsylvania that had an area of about 15,000 sq. ft. Their population density and abundance are estimated and discussed.

4. Sexual dimorphism is greatly developed in all three species. The males possess the brighter colors, grow more rapidly, attain a larger size, usually have larger anal, first and second dorsal fins, somewhat smaller pectoral fins and smaller anal papillae.

5. A significant departure from a 1:1 sex ratio occurred in the juvenile and adult age goups in which the samples included a large number of specimens for analysis. More males were collected in all age groups in the three species, and a tendency was noted for increased number of males in older age groups.

6. The age of 873 specimens of *Poecilichthys z. zonalis*, 416 *Poecilichthys variatus* and 176 *Etheostoma b. blennoides* was determined by scale analysis.

7. The annulus in the three species was formed during latter May and early June with the resumption of growth. It was formed somewhat earlier in the juveniles than in the breeding adults.

8. The scale structure is quite similar to that of the johnny darter. In the spring and early summer when growth is more rapid, the cerculi are farther apart than during the period of slower growth in late summer and fall. The annulus is easily seen on the anterior and lateral fields of the scale.

9. Reproduction is probably limited to the month of May and early June in Pennsylvania, varying with climatic factors. The variegated darter apparently spawns earliest, and the eastern banded darter spawns latest.

10. Individuals of all three species are mature and spawn when two years old; some *zonalis* are mature when only one year old, and a few spawn at this age.

11. These darters are relatively short lived. The typical life span is four years. Just one specimen, a northern greenside darter, had survived five summers.

12. The largest specimens recorded are: *blennoides, male,* 82 mm. in standard length, female, 75 mm.; *variatus,* male, 76 mm., female, 74 mm.; *zonalis,* male, 62 mm., female, 48 mm.

13. The males of the three species grow more rapidly than their respective females. This differential rate of growth is statistically significant at the end of the first summer of life.

14. *Etheostoma b. blennoides* grows more rapidly and attains a greater length than either *zonalis* or *variatus*. In *blennoides* from French Creek, Pennsylvania, the males attain a mean standard length of 40 mm. (34 to 46 mm.); 58 mm. (52 to 60 mm.); 68 mm. (60 to 74 mm.) and 77 mm. (74 to 82 mm.) at the end of their first, second, third and fourth summers. Females reach 38 mm. (34 to 42 mm.); 54 mm. (52 to 56 mm.); 60 mm. (54 to 64 mm.) and 60 mm. for the same growth periods. Similar data for *variatus* are: males, 35 mm. (26 to 40 mm.); 61 mm. (52 to 66 mm.); 67 mm. (60 to 74

mm.) and 73 mm. (70 to 76 mm.); females, 33 mm. (24 to 40 mm.); 55 mm. (44 to 60 mm.); 62 mm. (54 to 68 mm.) and 71 mm. (68 to 74 mm.); *zonalis*, males, 31 mm. (24 to 36 mm.); 40 mm. (34 to 48 mm.); 49 mm. (38 to 56 mm.) and 54 mm. (46 to 62 mm.); females, 29 mm. (20 to 36 mm.); 38 mm. (32 to 44 mm.); 43 mm. (38 to 48 mm.) and 46 mm. (42 to 48 mm.).

15. The annual increment in length is greatest during the first year in *zonalis* for both sexes. Annual growth increments are about equal for the first two years of life in *variatus* and *blennoides*, with greatly retarded growth during the last two years.

16. Variabilities in rate of growth within a species and within a sex, and the retardation of growth following maturity cause great overlaps in age-frequency distributions, so that estimations of age from length-frequency curves may be entirely erroneous.

ACKNOWLEDGMENTS

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Distribution of the Fishes of Boone County, Iowa, With Special Reference to the Minnows and Darters[1]

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During 1946 and 1947 an ecological study was made of the minnows and darters of the streams in Boone County, Iowa. This report discusses the distribution of the fishes known to occur in the county. Other aspects of the study will be reported later.

Boone County has a total area of 569 square miles and lies entirely in the Wisconsin drift soil area. Over 90 per cent of the county is rich farm land. Carrington loam, which is a very fertile soil, covers over 40 per cent of the county, and is confined mainly to rolling land bordering the creeks and smaller streams (Stevenson and Brown 1924). Boone County is interesting from a distributional viewpoint in that its watershed is drained by two separate river systems, both of which are part of the Mississippi system. The greater portion of the county is in the Des Moines River system. This river passes through Boone County about midway in its course, cutting a deep valley in otherwise rolling to flat land. At one point in the county, the total drainage of the river is 5,610 square miles. The stream gradient is 1.5 feet per mile in the lower 300 miles, including Boone County (U. S. 71st Congress Report). The bottom of the river is chiefly sand-gravel, with sand-silt, rubble and boulders in limited areas. The channel at low water stages varies in depth from 1.5 to 4 feet and the width of the river from approximately 100 to 250 feet. Deep holes are present below bars and at bends. In the Des Moines River 721 collections were taken at 17 places with 10, 20, and 30 feet common sense minnow seines (Fig. 1). Wire minnow traps were also used at a few locations.

All the streams in the county are in the Des Moines River watershed except for four small streams in the Skunk River watershed in the northeastern corner (Squaw Creek, Montgomery Creek, Prairie Creek, and Onion Creek). The Skunk River does not flow through the county, but lies some 20 miles to the east of the Des Moines.

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2 The writer wishes to express his appreciation to Drs. Kenneth D. Carlander and George O. Hendrickson of Iowa State College under whose guidance this investigation was made. Also the writer wishes to thank Mr. Don Briden and others for assistance in the field.

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Most of the streams in the county are small prairie creeks meandering through tilled and pasture land. The banks are mainly mud and the stream bottoms are sand in the presence of current and sand-silt in the pools. Emergent vegetation was abundant in only one stream examined. Two of the streams surveyed are confined largely to the bluffs and valley of the Des Moines River and are designated as bluff-creeks to distinguish them from the more sluggish prairie streams. The origin of one bluff-creek was traced to a tile drainage approximately four miles west of the river. A total of 100 collections were taken in the streams other than the Des Moines River. Silt was the only type of pollution observed in the streams surveyed. The headwaters of the smaller streams examined were found to be of tile drainage origin. During a drought period in August and September of 1947 many of the smaller streams were broken up into intermittent pools.

In the distributional tables, the data are not given for the individual streams but are grouped on the basis of the width of the stream at the point of collection, as follows: streams under 10 feet wide, streams 10 to 40 feet wide, and the Des Moines River.

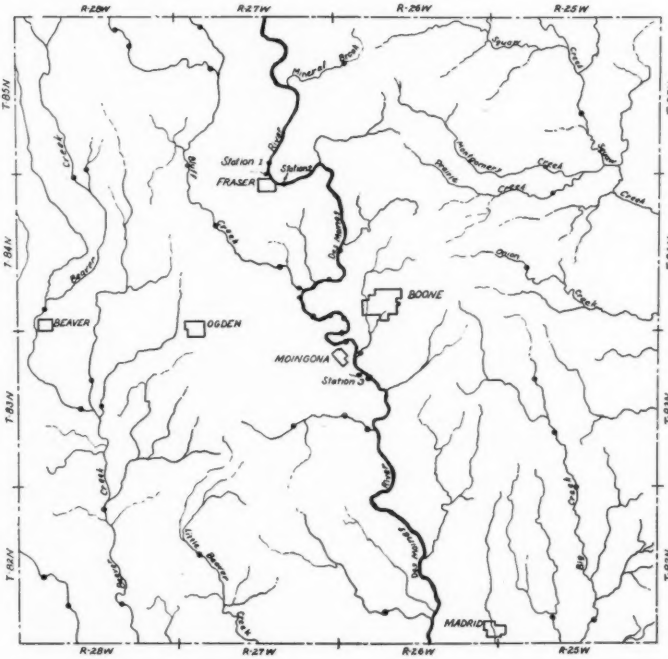

Fig. 1.—Points at which collections were taken in Boone County, Iowa, 1946 and 1947.

The emphasis in this investigation was on smaller fishes and as a result the data on the larger fishes were not satisfactory for quantitative use. The habitat preferences of the minnows (Cyprinidae) and darters (Etheostomatinae) are given in percentages based on the number of collections for a particular type of habitat divided into the number of these collections in which the species occurred (Tables 1, 2, 3, and 4). The percentage of occurrence in collections is also used to determine the relative abundance of a species (Fig. 2). This estimate of relative abundance was found to be a more accurate method than actual count of the number of individuals, provided 25 or more collections are made in an area of river not exceeding a quarter of a mile. Fewer collections do not permit an investigator to sample a sufficient number of habitats.

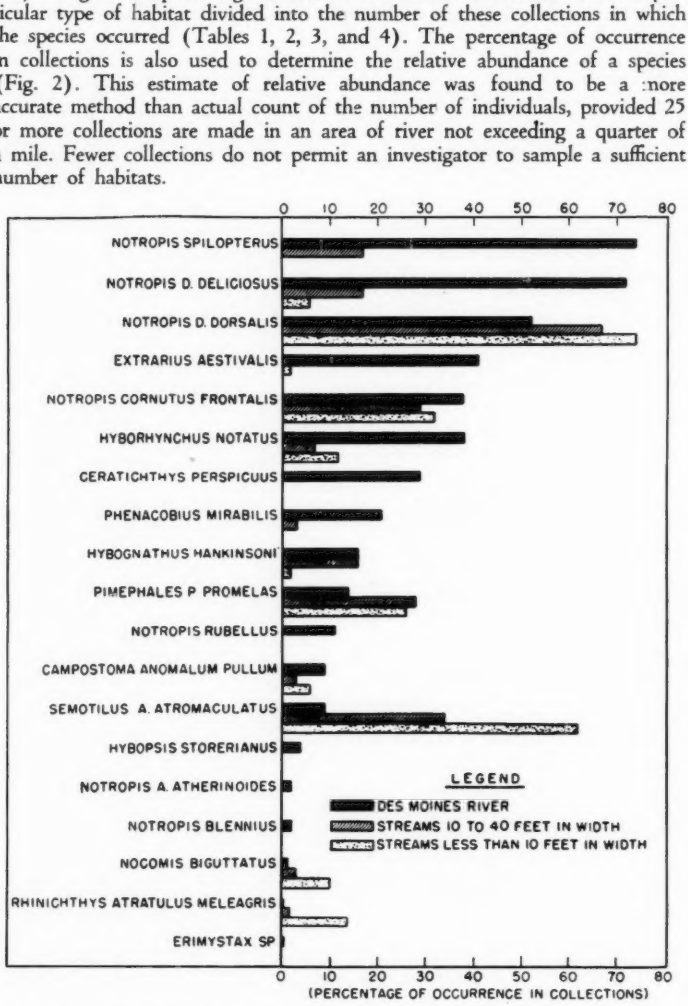

Fig. 2.—The abundance of minnows in Boone County, Iowa, streams during 1946 and 1947, based on percentage of occurrence in 719 collections.

In the latter part of the last century some fish surveys were made on various parts of the Des Moines River (Jordan and Meek 1885; Meek 1892; Cox 1896). Call's (1892) survey of the Des Moines River basin included a few Boone County streams. Bailey and Harrison (1948) mention the more abundant species of fishes occurring in the Des Moines River, Boone County. The nomenclature used by Hubbs and Lagler (1947) and Eddy and Surber (1947) is followed in the present paper. Fifty-three species of fishes are now known to occur in Boone County. Only one of these, the redfin, was not taken in the Des Moines drainage system. The Iowa State College Museum has specimens from the Des Moines River, Wapello County, more than a 100 miles down stream from Boone County. In the following list the species marked with an asterisk (*) were not taken in the present study. Specimens are in the fish collection at Iowa State College.

1. Bigmouth buffalo fish, *Megastomatobus cyprinella* (Valenciennes).—A few adult specimens were taken in the Des Moines River in April 1946.

2. Quillback, *Carpiodes cyprinus* (LeSueur).—The young and adults of the various species of *Carpiodes* occurred in 32 per cent of the river collections. This species was also taken in Beaver Creek.

3. Northern carpsucker, *Carpiodes carpio carpio* (Rafinesque).—This species was taken only in the Des Moines River.

4. Highfin sucker, *Carpiodes velifer* (Rafinesque).—This species occurred only in the Des Moines River collections.

5. Common white sucker, *Catostomus commersonnii commersonnii* (Lacépède).—This species appeared to be more abundant in 1946 than in 1947. It is found in larger prairie streams as well as the Des Moines River.

6. Hog sucker, *Hypentilium nigricans* (Le Sueur).—This species occurred in 3 per cent of the river collections. The hog sucker was not taken in the smaller streams.

7. Golden redhorse, *Moxostoma erythrurum* (Rafinesque).—This species occurred only in the Des Moines River collections.

8. Silver redhorse, *Moxostoma anisurum* (Rafinesque).—This species occurred only in the Des Moines River collections.

9. Northern redhorse, *Moxostoma aureolum* (Le Sueur).—This redhorse occurred more frequently in the river collections than the other species of *Moxostoma*.

10. Carp, *Cyprinus carpio* Linnaeus.—The carp is one of the two most important fishes for food and angling in Boone County. This species is much more abundant than is indicated by its occurrence in 6 per cent of the Des Moines River. The carp was not taken in streams less than 10 feet in width.

11. Northern creek chub, *Semotilus atromaculatus atromaculatus* (Mitchill).—This minnow is more abundant in the smaller streams than the river. The northern creek chub thrives in the headwaters of small creeks and is able to live in the small intermittent pools in late summer. The distribution of this species is like that of the central bigmouth shiner, except that the chub occurs in lesser numbers. The association index (Dice 1945) of the northern creek chub to the central bigmouth shiner is 0.93. In this instance the index reveals mainly that both species are widely distributed rather than indicating a close association.

12. Hornyhead chub, *Nocomis biguttatus* (Kirtland).—The hornyhead chub is not

abundant anywhere in Boone County. It occurred in only 1 per cent of the river collections. According to Hubbs and Cooper (1936) this species is absent from muddy, silt-bottomed and stagnant waters and prefers swift-water streams with gravel bottoms (because of its method of spawning). This species is probably limited by scarcity of such habitats in the county.

13. Silver chub, *Hybopsis storerianus* (Kirtland).—This species is confined to the river and occurred there in only 4 per cent of the collections.

14. Speckled dace, *Extrarius aestivalis* (Girard).—The speckled dace is mainly confined to the river where it occurred in 41 per cent of the collections. It occurred in only 2 per cent of the collections in streams between 10 and 40 feet and was not taken in any of the smaller streams. This species uses the channel of the river more than do other minnows. The scarcer silver chub was occasionally taken in the channel with the speckled dace. The spotfin shiner, southwestern sand shiner, and northern common shiner frequently occurred in the channel collections, however, in lesser numbers than the speckled dace. This dace during the winter of 1946-47 continued to use the river channel at Fraser (Station 2) even though it was not covered with ice. The other species of minnows at this station in winter were seldom collected from the ice free channel.

15. Spotted chub, *Erimystax* sp.—Two specimens taken from the Des Moines River in 1946 were checked by Dr. C. L. Hubbs. A revision of the genus *Erimystax* is now being prepared by Dr. Hubbs and Crowe. The two specimens were taken over sand-gravel bottom with current and occurred with central bigmouth shiners.

16. Western blacknose dace, *Rhinichthys atratulus meleagris* Agassiz.—This dace was found to be mainly confined to the upper stretches of small bluff-creeks and occurred in 75 per cent of the collections from such streams (Range from 0 to 82 per haul with 10 foot seine), as compared to 14 per cent in other streams of comparable size. This species occurred in only 2 Des Moines River collections, each of which had only a single individual. These specimens were possibly recently introduced from fishermen's minnow pails. The distributional data in the tables indicate that the western blacknose dace is limited in its distribution in the county and that such limitation seems to be related to its definite habitat preference for small streams and for a steeper stream gradient than is present in the sluggish prairie streams. Few other species in the county show as marked a habitat preference.

17. Western golden shiner, *Notemigonus crysoleucas auratus* (Rafinesque).—On July 9, 1947, five specimens were taken from a temporary pool adjacent to the Des Moines River following a high water period. This species may be present in some numbers in the deeper waters above the two lowhead dams in the Des Moines River in the county. However, none was taken in collections from such waters. Near Moingona, one specimen was taken in April 1946.

18. Common emerald shiner, *Notropis atherinoides atherinoides* Rafinesque.—This shiner was present in the river in small numbers and was not taken in any other streams within the county.

19. Rosyface shiner, *Notropis rubellus* (Agassiz).—The rosyface shiner occurred in 11 per cent of the collections, usually only a few specimens at a time. The adults of this species were found in association with adult spotfin shiners. The rosyface shiner is limited to the Des Moines River in its distribution in Boone County.

20. Northern common shiner, *Notropis cornutus frontalis* (Agassiz).—The northern common shiner was fairly abundant in most of the streams surveyed. This shiner is found in swift water as well as quiet pools. In the Des Moines River it was usually associated with the spotfin shiner, southwestern sand shiner, and bluntnose minnow.

21. Spotfin shiner, *Notropis spilopterus* (Cope).—This species and the southwestern sand shiner were determined to be the most abundant fishes in the Des Moines River. The

spotfin shiner was not taken in streams less than 10 feet in width. It did not occur in the collections from the creeks in the northeastern part of the county which are a part of the Skunk River drainage, and various collections in the Skunk River, Story County, have failed to reveal its presence in that river. Call (1892) includes the spotfin shiner as part of the Squaw Creek fauna (Skunk drainage); however, he describes this species as having either brilliant yellow or red fins which leads the present writer to believe that Call confused the spotfin shiner with the redfin. All male specimens of the spotfin shiner in breeding colors examined from the Des Moines River had yellowish or orange-black colored fins; whereas, the redfins from Squaw Creek had reddish colored fins. This difference between these two species is corroborated by current descriptions (Eddy and Surber 1947).

22. Redfin, *Notropis lutrensis lutrensis* (Baird and Girard).—The redfin is not known to occur in the Des Moines River system in Boone County. It occurs fairly abundant in Squaw Creek and Onion Creek which are part of the Skunk River drainage system.

23. River shiner, *Notropis blennius* (Girard).—This shiner was confined to the Des Moines River and was not abundant. It occurred in only 2 per cent of the river collections. Records in the Iowa State College Museum of collections taken by Dr. Reeve M. Bailey on May 15, 1940, indicate that on this date the river shiner was very common in the Des Moines, Boone County. Apparently this species is subject to fluctuations in numbers as evidenced by its scarcity in the river through 1946 and 1947.

24. Central bigmouth shiner, *Notropis dorsalis dorsalis* (Agassiz).—The central bigmouth shiner is the most successful fish in Boone County insofar as wide distribution and general abundance are concerned. It is a pioneer fish in the small creeks and its abundance tends to decrease with increase in stream size over 10 feet in width. This decrease is not enough to prevent it from being one of the three most abundant species in the Des Moines. On several occasions collections taken over sand bars newly covered by a rising river were composed mainly of central bigmouth shiners, indicating its ability to make use of a newly formed habitat. The southwestern sand shiner and spotfin are most frequently associated with the central bigmouth shiner in the Des Moines River. In the smaller streams the northern creek chub and northern common shiner are most frequently associated with the central bigmouth shiner.

25. Southwestern sand shiner, *Notropis deliciosus deliciosus* (Girard).—During the two year investigation on the Des Moines River this species was determined to be the second most abundant species in the river. It is largely confined to streams over 10 feet in width, including the Skunk River drainage streams. A thorough taxonomic study of this species in Boone County might establish the presence of intergradations between *N. d. deliciosus* and *N. d. missuriensis*. Variation was found in two populations studied, indicating a tendency toward such an intergradation.

26. Topeka shiner, *Notropis topeka* (Gilbert).—This species was not taken from the Des Moines River during this investigation. The Iowa State College Museum has one specimen collected by Dr. R. M. Bailey from the Des Moines River in Boone County on September 24, 1939. This species was found in the present investigation to be fairly common in Beaver Creek, a tributary of the Des Moines.

27. Suckermouth minnow, *Phenacobius mirabilis* (Girard).—In the river this species was found to show a definite preference for rubble bottom and current. It was not taken in streams less than 10 feet in width. The number of specimens of suckermouth minnow in the river collections ranged from 0 to 82.

28. Brassy minnow, *Hybognathus hankinsoni* Hubbs.—The brassy was taken in limited numbers in streams of all sizes. It was most frequently in inlets and pools in the river.

29. Fathead minnow, *Pimephales promelas promelas* (Rafinesque).—The fathead was taken in small numbers in the various sizes of streams. In only one stream was it fairly abundant (15 to 75 were taken per haul with 10 foot seine). This stream, a small unnamed stream in the southwestern part of the county (Union Twp., Sec. 28), was the only

stream studied which had emergent vegetation growing in the pools. In this habitat other species of minnows were scarce and the brook stickleback was the only other abundant fish. Hubbs and Cooper (1936) state that the fathead minnow does not succeed under severe competition with other fishes and apparently cannot maintain itself in considerable numbers in large lakes or streams. The abundance of the fathead minnow in most of the streams is then possibly restricted by its limited tolerance to other species.

30. Bullhead minnow, *Ceratichthys perspicuus* (Girard).—The bullhead minnow was found to be one of the more abundant species of minnows in the Des Moines River, but was not taken in other streams. This species was found more abundantly in backwaters and pools than in any of the other habitats. The preference of this fish for muddy backwaters and bayous of large and medium sized rivers is mentioned by Hubbs and Black (1947).

31. Bluntnose minnow, *Hyborhynchus notatus* (Rafinesque).—The bluntnose minnow was found to be more abundant in the river than in the smaller streams. In the fall of the year in water temperatures ranging from 40° to 50° F. adults of this species were found to be abundant in presence of current over a gravel to sand-silt bottom. In this habitat the spotfin shiner and northern common shiner were also present in fairly large numbers. This association was found to be disbanded at temperatures below 40° F. At the lower temperatures the adult bluntnose minnows were found with the fish of the year in deep pools.

32. Central stoneroller, *Campostoma anomalum pullum* (Agassiz).—This species was not abundant in any of the streams. In the river the stoneroller indicated some preference for a rubble bottom in the presence of current.

33. Southern channel catfish, *Ictalurus lacustris punctatus* (Rafinesque).—This species occurred in 15 per cent of the Des Moines River collections. Specimens were not taken elsewhere in the county. This is the only abundant game fish in the river.

34. Northern black bullhead, *Ameiurus melas melas* (Rafinesque).—The bullhead was found in all sizes of streams. It occurred more abundantly in the Beaver Creek collections than elsewhere and was not abundant in the Des Moines.

35. Flathead catfish, *Pilodictus olivaris* (Rafinesque).—A few specimens of this species taken by anglers from the Des Moines River were observed.

36. Stonecat, *Noturus flavus* Rafinesque.—The stonecat does not occur abundantly in the Des Moines River. A few specimens were taken in the smaller streams.

37. Northern pike, *Esox lucius* Linnaeus.—A few specimens were taken in the Des Moines River during this investigation.

38. American eel,* *Anguilla bostoniensis* (LeSueur).—One specimen, 435 mm. total length, now in Iowa State College Museum, was taken in the Des Moines River, Boone County, by Maurice F. Baker on July 10, 1937.

39. Yellow perch, *Perca flavescens* (Mitchill).—The perch is not common in the river. A few small specimens were taken in the Des Moines River in 1946 and 1947. This species was not taken elsewhere in the county.

40. Yellow pikeperch, *Stizostedion vitreum vitreum* (Mitchill).—This species is confined to the Des Moines River where it is not abundant.

41. Blacksided darter, *Hadropterus maculatus* (Girard).—The blacksided darter was found to be confined to the Des Moines River, and occurred in the collections usually only as single specimens. No habitat preference was determined for this species.

42. Slenderhead darter, *Hadropterus phoxcephalus* (Nelson).—This darter was taken

only in the Des Moines River. The occurrence of this species in the collections was usually limited to a single specimen. The slenderhead darter showed a habitat preference for a rubble bottom in the presence of current.

43. Western sand darter, *Ammocrypta clara* (Jordan and Meek).—The western sand darter occurred only in the Des Moines River collections, where it showed a habitat preference for sand bottom in the presence of current. This darter occurred mainly in the mid-summer collections. Normally this species is difficult to net because of its habit of partially burrowing itself in sand, however, in mid-summer it tends to move more. This activity seems to have been associated with its spawning season as evidenced by gravid females taken in mid-summer. The collections at this season contained as many as eleven specimens. This species is probably more abundant than is indicated by its occurrence in 4 per cent of the collections.

44. Central Johnny darter, *Boleosoma nigrum nigrum* (Rafinesque).—The central Johnny darter was determined to be the most abundant and widely distributed darter in the county. This species did not show any particular habitat preference. The central Johnny darter never occurred in numbers exceeding 15 in the Des Moines River collections. Usually the occurrences represented a single specimen.

45. Eastern banded darter, *Poecilichthys zonalis zonalis* Cope.—Two specimens of this darter were collected in the Des Moines River during the winter of 1946-47. There are no other records of this species in the county.

46. Striped fantail darter, *Catonotus flabellaris lineolatus* (Agassiz).—A single specimen of this darter occurred in the Des Moines River collections. This species was found to be fairly abundant in the upper 5 miles of Bluff Creek and was not taken in any of the other streams.

47. Northern smallmouth bass, *Micropterus dolomieu dolomieu* Lacépède.—This species was not abundant in 1946 and 1947 in the Des Moines River. During this period only one bass of the year was taken. Young were found to be abundant in two tributary streams, indicating that in some years the river bass may be of small stream origin. During 1946 and 1947 high-river stages occurred on the Des Moines in late spring and probably provided unfavorable spawning conditions for bass. In 1948, a year of low water, smallmouth bass spawned successfully in the Des Moines River.

48. Green sunfish, *Lepomis cyanellus* Rafinesque.—This sunfish occurred in only 1 per cent of the Des Moines River collections. A few specimens were taken in smaller streams.

49. Orangespotted sunfish, *Lepomis humilis* (Girard).—This species occurred in 4 per cent of the Des Moines River collections. A few specimens were taken in the smaller streams.

50. Northern rock bass,* *Ambloplites rupestris rupestris* (Rafinesque).—Mr. Harry M. Harrison, Jr., of the Iowa State Conservation Commission, has in his collection at Madrid, Iowa, a specimen of this species taken by him in 1946 from the Des Moines River, Boone County.

51. White crappie, *Pomoxis annularis* Rafinesque.—This species is confined to the Des Moines River and occurred only occasionally in collections taken in deep pools.

52. Black crappie,* *Pomoxis nigro-maculatus* (LeSueur).—The black crappie is recorded from the river Boone County by Bailey and Harrison (1948). This species is rare in the Des Moines.

53. Brook stickleback, *Eucalia inconstans* (Kirtland).—A single specimen was taken in a minnow trap in the Des Moines River during high-water in 1947. This record of the brook stickleback in the Des Moines River, Boone County, should be considered as accidental. This species is confined in its distribution in the county to a single unnamed prairie stream in the southwestern part of the county (Union Twp., Sec. 28). Here the stickleback occurs abundantly with the fathead minnow.

HOURLY AND SEASONAL CHANGES IN HABITAT BY MINNOWS

Large concentrations of minnows are often seen in the shallow quiet inlets in mid-summer along the Des Moines River. These quiet inlets have a rich bottom microflora. The majority of the species found in this habitat during the day feed on these bottom forms. The July 1946 seining data indicate an abundance of southwestern sand shiners, central bigmouth shiners and young-of-the-year *Carpiodes spp.* in the inlets during the day and the scarcity of spotfin shiners. The spotfin shiners moved into this shallow habitat at dusk and remained there throughout the night. Raise-net samples in mid-stream revealed the presence of spotfin shiners in some numbers during the day and their absence at night. Collections taken in late July 1947 substantiate the 1946 findings on the diurnal and nocturnal habitat selection of the spotfin shiner. There is some tendency for the spotfin shiner to move inshore at dusk throughout the remainder of the summer and fall. During the day they are usually dispersed in deeper water and seldom occurred in large numbers in the collections. Occasionally in the fall and spring this shiner showed a tendency to school in association with the northern common shiner and bluntnose minnow.

During the spawning period in early August the southwestern sand shiner forms large schools in limited areas in shallow water where there is a slight current and sand bottom. In the fall this species is found in large concentrations in deep pools. The fall concentrations examined were mixed and contained as many as 14 species of minnows, dominated by the southwestern sand shiner. In late summer and fall, the southwestern sand shiners moved into shallow water over rubble bottom at dusk and they were accompanied with lesser numbers of spotfin shiners and central bigmouth shiners (Table 5). The suckermouth minnow was also found to move into shallower water over rubble bottom in the evening in association with the above mentioned shiners. During the day the suckermouth minnow often occurred with the speckled dace in the deeper water over rubble. The latter species was never found to show any tendency to move into shallow water at dusk. In extremely low water periods the speckled dace was somewhat concentrated in the channel over gravel bottom.

In late fall large mixed concentrations composed mainly of the bullhead minnow, bluntnose minnow, and brassy minnow were encountered in deep quiet pools. Such concentrations are found divorced from the dominant southwestern sand shiner concentrations described above. Concentrations of the bullhead minnow were found in the backwaters during high-water periods in late spring. Collections at this period often contained over 300 specimens whereas collections of this species at other seasons were usually small.

To verify the 1946 findings on movements of minnows, wire traps were used in the spring, summer, and fall of 1947. The traps were used on 24 days and were examined at 1-2 hour intervals. The spotfin shiner, southwestern sand shiner, and bullhead minnow were the only species taken abundantly. The activity of these fishes was almost wholly confined to the daylight hours, and often was most pronounced just at dusk. The activity at dusk may be correlated with the movement from deep to shallow water.

DISCUSSION

The number of species of fishes in Boone County increases with stream size and watershed similar to Thompson and Hunt's (1930) findings in Illinois; however, the species of fish, particularly the minnows, in central Iowa differs from those found in eastern Illinois. In Champaign County, Illinois, the silverjaw minnow (*Ericymba buccata* Cope) appears to be an ecological equivalent of the widely distributed central bigmouth shiner in Boone County. The former species does not occur in Boone County, whereas the central bigmouth shiner is found in Champaign County only in one river basin. Regardless of faunal differences, similar fish associations and ecological equivalents are present in both of these midwestern localities.

In the distribution of the fishes in Boone County, 51 per cent of the species are confined to the Des Moines River. Of the remaining 49 per cent, only one species, the redfin, is not known to occur in the Des Moines. The northern black bullhead is the most widely distributed of the larger fishes in the county. This fish occurs in all sizes of streams. Of the 22 species of minnows known to occur in the Des Moines, 32 per cent are confined to the river. The central bigmouth shiner and northern creek chub occur as pioneer fish in the headwaters of small trickling, prairie streams as well as the river. The bullhead minnow, common emerald shiner, river shiner, and silver chub are the more abundant species of minnows limited to the river. Several consecutive years of unsuccessful spawning in the river could extirpate these species; whereas a widely distributed species like the central bigmouth shiner and common northern creek chub could soon repopulate the river from the tributaries.

Some of the minnows are rare and might be considered unimportant from a fish population standpoint. Grinnell (1922a, 1922b) discusses the potentialities of rare and accidental birds in California. In California it was found that a rare or accidental species of bird might become more abundant as a result of change in habitat to a more favorable environment. These rare species serve as possible sources of change in the population. Two rare species of minnows in the Des Moines River, the spotted chub and the topeka shiner, possibly have such latent possibilities. Two specimens of the spotted chub were taken from the river in 1946 and it was not found to occur elsewhere in the county. The single record of the topeka shiner is discussed in an earlier section. This species is fairly abundant in Beaver Creek, a tributary of the Des Moines. Evidently the environment is not favorable at the present time for the establishment of these two species in the river; however, the occasional specimens entering from the tributary streams might serve as the beginning of a new population if conditions became favorable. A change to a favorable environment in the river for one of these species might have a measurable effect on some of the other species now abundant in the river. In Beaver Creek, the spotfin shiner and southwestern sand shiner occurs with the topeka shiner. The bullhead minnow, which is an abundant minnow in the river, was conspicuously absent from the collections in this stream. Also the speckled dace occurs in very small numbers in Beaver Creek as compared to the Des Moines. The delicate balance of conditions permitting the existence of species composing the mixed river population is of basic importance in the understanding of popula-

tion dynamics. A slight change in environment may bring about changes in species composition and in abundance of the fish population. Some of these fluctuations were noted in the present study. The rare species might be disregarded as unimportant parts of the fish population if the environment would remain the same, but with changing environments, the accidental and rare species may have especial significance.

Burton and Odum (1945: 193) conclude from their study of stream fish in Virginia that ". . . of the various environment complexes considered, temperature, stream size, and gradient of flow appeared to be the most important factors in determining distribution within streams studied." In Boone County, temperature associated with oxygen may be of importance to survival in the intermittent pools formed in late summer in some of the smaller streams. The lowest oxygen reading made in an intermittent pool was 2.4 ppm., with a water temperature of 82°F. and air of 88°F. The fish fauna in these pools was mainly: central bigmouth shiner, northern creek chub, northern common shiner, central stoneroller, and the northern black bullhead. Shelford (1937) mentions the hardiness of the creek chub (*Semotilus atromaculatus*) in small drying pools, and indicates that most fishes cannot survive such conditions. The two most abundant species of minnows in the Des Moines River are probably not hardy enough to maintain a population in the smaller creeks as evidenced by their scarcity in or absence from such streams. The physiological requirements of these fishes (spotfin shiner and southwestern sand shiner) are not known to the writer, but in handling minnows it was found that these two species succumbed more readily under crowded conditions and reduced oxygen than did the two common species found in the small streams (central bigmouth shiner and northern creek chub). The inability of certain abundant species in the river to withstand oxygen reduction and the crowded conditions in small intermittent pools in late summer is considered the important factor in preventing their wider distribution. Trautman (1942) discusses the importance of stream gradient in fish distribution and abundance. In Boone County the steepest stream gradient was noted in the bluff-creeks and here, as already mentioned, the western blacknose dace occurs. Other than in this type of stream, the streams are sluggish and have a low stream gradient. The factor of species intolerance has been discussed as a possible limiting factor for the fathead minnow.

SUMMARY

There are 53 species of fish known to occur in Boone County, Iowa, streams. The redfin is the only one not found in the Des Moines River drainage.

The number of species was found to increase with increased stream width and watershed.

The fish population in the county is mainly composed of minnows. There are 23 species of minnows known to occur in the county.

The hardiness of a species to withstand low oxygen and limited space is considered an important factor in limiting the number of species in small streams subject to partial drying.

Intolerance to other species is probably an important factor in the local abundance of the fathead minnow.

Some species tend to have a limited distribution because of ecological preference.

In the river, habitat preference varied among some species with light intensity and season. The speckled dace remained in the channel regardless of light and season.

Rare or accidental species may be of special significance since they may serve as sources of population change when the environmnt changes.

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TABLE 1.—Percentage of occurrence of minnows in various habitats in the Des Moines River, Boone County, 1946-47.

Season	Open water period, not flood stage								High Water period			Winter		Combined
Habitat	Inlets	Pools	Stream	*Mid-stream	Stream	Stream	Stream	Stream	Margin	Stream	Stream	*Mid-stream	**Edge	
Current	none	none	present	present	present	present	present	present	none	present	present	present	present	
Bottom	sand-silt	sand-silt	sand	sand	rocks	sand-gravel	sand-silt	rubble	sand-silt	sand	sand-silt			
Depth in feet	0-1.5	1.5-5.0	0-2.5	1.5-3.0	2-3	0-2.5	0-2.5	0-2.5	0-3	0-3	0-3	2-3	0.5-1.5	
Number of collections	63	34	156	44	19	121	86	16	20	13	22	11	14	619
Notropis spilopterus	76	91	84	30	84	78	64	56	100	100	95	18	50	74
Notropis deliciosus	89	76	74	25	11	78	65	88	95	92	86	55	86	72
Notropis d. dorsalis	71	62	53	11	11	61	48	56	65	38	50	18	71	52
Extrarius aestivalis	8	9	49	48	0	55	30	75	20	54	95	55	57	41
Notropis cornutus frontalis	37	65	34	36	26	47	33	50	50	8	32	27	36	38
Hyborhynchus notatus	46	68	35	7	42	31	36	56	90	77	50	0	21	38
Ceratichthys perspicuus	27	41	26	0	11	25	29	50	80	46	95	0	14	29
Phenacobius mirabilis	21	6	12	0	5	42	16	69	20	23	18	0	57	21
Hybognathus hankinsoni	37	35	11	2	0	20	13	13	10	8	9	9	7	16
Pimephales p. promelas	32	32	15	2	11	7	14	6	10	23	9	0	0	14
Notropis rubellus	13	18	8	7	0	14	15	13	15	15	27	0	7	11
Campostoma anomalum pullum	17	9	3	0	16	14	7	25	5	15	0	0	7	9
Semotilus a. atromaculatus	6	12	3	0	11	13	10	6	25	0	9	0	21	9
Cyprinus carpio	8	15	8	0	5	2	6	0	10	7	5	0	0	6
Hybopsis storerianus	0	6	7	0	0	2	3	0	5	0	9	0	0	4
Notropis a. atherinoides	2	3	2	11	0	1	2	0	10	0	0	0	0	2
Notropis blennius	0	6	3	0	0	2	0	0	5	8	0	0	0	2
Nocomis biguttatus	0	0	0	0	0	2	2	0	0	15	0	0	0	1
Rhinichthys atratulus meleagris	2	0	1	0	0	0	0	0	0	0	0	0	0	T
Erimystax sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	T

* Mid-stream samples were taken by the "raise-net" method. ** Net was held at edge of ice and fish were driven out from under the ice into the open stream.

Nocomis biguttatus	0	0	0	0	0	2	0	0	0	0	0	0	0	2
Rhinichthys atratulus meleagris	2	0	1	0	0	0	0	0	0	0	0	0	0	T
Erimystax sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	T

* Mid-stream samples were taken by the "raise-net" method. ** Net was held at edge of ice and fish were driven out from under the ice into the open stream.

TABLE 2.—Percentage of occurrence of darters in various habitats in the Des Moines River, Boone County, 1946-47.

Season	Open water period, not flood stage								High Water period			Winter		Combined
Habitat	Inlets	Pools	Stream	*Mid-stream	Stream	Stream	Stream	Stream	Margin	Stream	Stream	*Mid-stream	**Edge	
Current	none	none	present	present	present	present	present	present	none	present	present	present	present	
Bottom	sand-silt	sand-silt	sand	sand	rocks	sand-gravel	sand-silt	rubble	sand-silt	sand	sand-silt			
Depth in feet	0-1.5	1.5-5.0	0-2.5	1.5-3.0	2-3	0-2.5	0-2.5	0-2.5	0-3	0-3	0-3	2-3	0.5-1.5	
Number of collections	63	34	156	44	19	121	86	16	20	13	22	11	14	619
Hadropterus maculatus	5	18	4	0	10	15	3	0	20	23	18	0	7	9
Hadropterus phoxcephalus	0	0	1	0	5	5	2	13	40	23	36	0	0	5
Boleosoma n. nigrum	17	18	11	0	16	21	12	6	25	38	23	0	0	15
Poecilichthys z. zonalis	0	0	0	0	0	0	0	6	0	0	0	9	7	T
Ammocrypta clara	0	3	11	0	0	2	1	0	0	0	5	0	0	4
Catonotus flabellaris lineolatus	0	0	0	0	0	0	0	0	0	8	0	0	0	T

* Mid-stream samples were taken by the "raise-net" method. ** Net was held at edge of ice and fish were driven out from under the ice into the open stream.

TABLE 3.—Percentage of occurrence of various species of fish in collections from streams 10 to 40 feet in width, Boone County, Iowa, 1947.

Bottom Type	Sand-silt	Sand-rubble	Sand-gravel	Combined
Number of Samples	(11)	(23)	(24)	(58)
Cyprinidae				
Notropis d. dorsalis	82	39	88	67
Semotilus a. atromaculatus	45	17	46	34
Notropis cornutus frontalis	18	43	21	29
Pimephales p. promelas	45	22	25	28
Notropis spilopterus	36	17	8	17
Notropis d. deliciosus	45	9	13	17
Hybognathus hankinsoni	36	9	13	16
Hyborhynchus notatus	27	13	4	7
Notropis topeka	27	4	0	7
Phenacobius mirabilis	9	4	0	3
Campostoma anomalum pullum	0	9	0	3
Nocomis biguttatus	0	9	0	3
Notropis l. lutrensis	0	4	4	3
Cyprinus carpio	9	0	0	2
Rhinichthys atratulus meleagris	0	0	4	2
Extrarius aestivalis	0	0	4	2
Other fishes				
Carpiodes cyprinus	9	0	0	2
Catostomus c. commersonnii	18	0	0	3
Ameiurus m. melas	18	0	0	3
Noturus flavus	9	0	0	2
Lepomis cyanellus	0	4	0	2
Lepomis humilis	0	9	4	5
Micropterus d. dolomieu	18	4	0	5
Boleosoma n. nigrum	9	4	0	3

TABLE 4.—Percentage of occurrence of various species of fish in collections from streams less than 10 feet in width, Boone County, Iowa, 1947.

Habitat	Prairie Stream	Prairie Stream	Prairie Stream	Bluff Creek	Prairie Stream	Vegetated Pools	Open Pools	Combined
Bottom Type	Sand-silt	Sand	Sand-gravel	Rubble	Rubble	Sand-silt	Sand-silt	
Number of collections	4	23	2	8	2	6	5	50
Cyprinidae								
Notropis d. dorsalis	75	96	50	75	100	33	20	74
Semotilus a. atromaculatus	50	65	0	75	50	83	40	62
Notropis cornutus frontalis	25	26	50	50	0	17	60	32
Pimephales p. promelas	0	22	50	13	0	83	20	26
Rhinichthys atratulus meleagris	0	4	0	75	0	0	0	14
Hyborhynchus notatus	50	0	50	25	0	0	20	12
Nocomis biguttatus	0	13	50	0	0	0	20	10
Campostoma anomalum pullum	0	4	0	0	0	17	20	6
Notropis d. deliciosus	0	9	0	13	0	0	0	6
Notropis topeka	0	0	0	0	0	33	0	4
Hybognathus hankinsoni	0	0	0	0	0	17	0	2
Other fishes								
Ameiurus m. melas	0	0	0	0	0	17	20	4
Boleosoma n. nigrum	0	13	0	0	0	0	20	8
Catonotus flabellaris lineolatus	25	13	0	0	0	0	20	10
Eucalia inconstans	0	0	0	0	0	67	20	10

TABLE 5.—Comparison of night and day collections of four species of minnows taken over shallow sand-gravel bars during late summer and fall.*

	Number of fish per haul			
Time	0800-1800		2000-0500	
Number of collections	(17)		(17)	
	Mean	Range	Mean	Range
Notropis d. deliciosus	27	0-244	102	4-521
Notropis spilopterus	10	0-56	18	0-133
Notropis d. dorsalis	6	0-16	15	0-95
Phenacobius mirabilis	2	0-5	12	0-82

* All samples were taken with 20 foot minnow seine. The collections dates were from August 23 through November 5, 1946, Des Moines River. Depth was 0 to 1.5 feet and some current was present.

Effects of Sewage and of a Headwaters Impoundment on the Fishes of Stillwater Creek in Payne County, Oklahoma*

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Introduction

The relative abundance of fishes in Stillwater Creek and principal tributaries, Payne and Noble Counties, Oklahoma, was studied in 1938 (Moore and Mizelle, 1939). During this 20-station survey the mainstream and tributaries above the city of Stillwater consisted of intermittent pools. Below Stillwater a slight flow was maintained by city sewage outlets. At that time something less than 750,000 gallons of processed sewage entered the stream daily. The quantity and quality of this influx did not markedly influence the stream's turbidity or its abundance of fishes. The entire stream was, and undoubtedly had long been, extremely muddy. Its water level fluctuated widely, floods followed by reduction to intermittent pools occurring almost annually.

Since the previous survey was completed the character of the stream has been considerably altered, as as result of (1) construction in 1938 of Lake Carl Blackwell, a 3,300 acre flood control impoundment 16.37 river miles upstream from Stillwater, and (2) increase in the stream's sewage load to 1,600,000 gallons daily, 850,000 gallons of which are untreated. Lake effects have been: (1) maintenance of flow through formerly intermittent portions of the stream produced by continuous release of water through one lake outlet valve, which cannot be completely closed; (2) stabilization of flow, resulting from the collection of runoff water in the lake, followed by gradual release into the stream; (3) reduced creek turbidity, resulting from the lake's settling action; (4) increased variety of the fish fauna, produced by the introduction of exotic fishes into the lake by Government agencies, bait dealers, and fishermen, and the subsequent escape of such fishes into the creek through the outlet valves; and (5) release of a certain quantity of fish food organisms into the creek through the outlet valves. As proof of (5), *Notropis lutrensis* taken in spring and early summer immediately below the dam were found to be gorged with *Chaoborus* (an organism abundant only in the lake)—a situation not noticed elsewhere in the creek. Influences of the increased sewage load below Stillwater have been: (1) reduced soil turbidity and increased fertility, which have

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stimulated the production of large amounts of fish food; and (2) occasional oxygen deficiency which has resulted in fish kills.

A second survey begun in October 1947 and completed in July 1948 disclosed significant changes in the species composition and relative abundance of fishes as a result of these changed ecological conditions. Of the 28 species found by Moore and Mizelle, 26 were taken again, for the most part in increased abundance. Representatives of the remaining two species were seen. Fourteen additional species are herein reported as first official records for the stream system.

Physical Aspects of the Stream

The portion of the mainstream involved in the survey meanders 38.37 miles through Permian red-bed from Blackwell Lake to its junction with the Cimarron River. The channel averages 20 to 30 feet wide, has steep banks and a mud bottom, and is less than four feet deep. Sand bottoms occur in Spring Creek, parts of Little Stillwater Creek, in the mainstream immediately below the mouth of Little Stillwater Creek, and at the extreme mouth of Stillwater Creek (Fig. 1). Stream banks are well covered with elm, oak, pecan, and cottonwood, with a considerable shrub and weed growth beneath. The channel is littered with logs and brush. Near the stream mouth the channel broadens to a width of about 80 feet, yet retains an average depth of three to four feet, the rate of flow in this section ordinarily being less than one-half foot per second. The water is so nearly still that on quiet days an algal scum sometimes covers the surface.

Methods

Six of the 1938 survey stations were chosen as the most advantageous collecting sites (Fig. 1). Collections, equally intensive, were made at stations "A", "C", "D", and "F" at approximately three-week intervals. Stations "B" and "E" were less frequently visited. The data obtained from these standardized collections are compiled in Table 1. Additional observations and corroborative collections were made when population fluctuations demanded further investigation.

A 10-foot ¼-inch mesh seine proved to be the most effective collecting instrument available, and was used almost exclusively. However, a 20-foot seine and a 100-foot seine were occasionally used as checks on the reliability of samples and for other special purposes. A gill net was tried, unsuccessfully, and the method was discarded. A 4- by 3-foot bobbinet seine and a piece of window screening were employed for checks on pelagic spawning and for collection of fry.

Water-quality tests were confined to determinations of temperature, pH, and dissolved-oxygen (using the Rideal-Stewart modification of the Winkler method).

Descriptions of Stations

Station "A" included parts of the broad, usually quiet portion of the mainstream near its mouth. The total abundance of fishes was greater here than at any other station. In connection with this station, collections were often

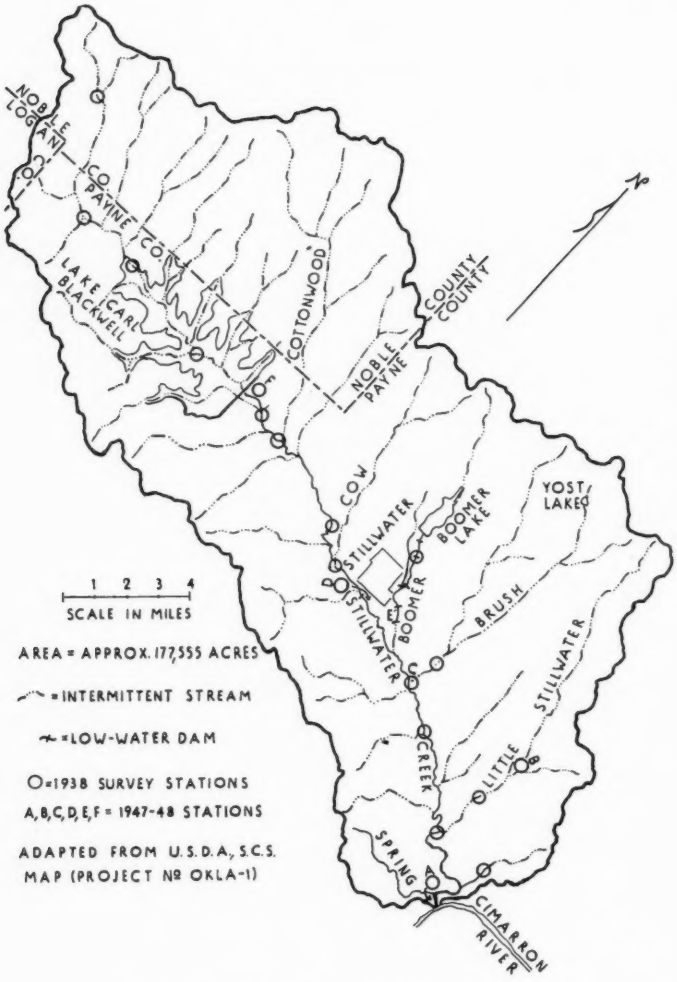

Fig. 1.—Map of the Stillwater Creek Drainage Basin.

made in Spring Creek, which enters the mainstream about 500 yards above the creek mouth. Spring Creek is ecologically very different from other habitats in the drainage basin, consisting principally of long shallow stretches of fast water flowing over a sand bottom. Spring fed and clear, this tributary flows about two cubic feet per second exclusive of runoff water.

Station "B", on Little Stillwater Creek, provided the intermittent habitat characteristic of much of the draining basin. Collections from detached pools were made October 16 and February 28. On the former date seven species were found, four of which were abundantly represented. The latter collection, however, produced no fish, winter kill and depredations by raccoon and other terrestrial predators apparently having extirpated them. After rains March 21 and 22 (0.84 inch) and June 28 (1.43 inches) collections were made from the flowing stream. Fishes were least abundant at this station.

Station "C" was strategically located with respect to the determination of sewage effects. Fishes were abundant except under extreme low-water conditions, when oxygen deficiency caused fish kills. Collections were made from the narrow, brush-littered mainstream and from a large pool of backwater at the mouth of intermittent Brush Creek.

Station "D" was in the region of the Stillwater sewage plant outlets, and was bounded upstream by a low-water dam—the only such structure in the mainstream. A moderate to strong flow over this dam was maintained except between November 24 and January 1, and between April 1 and June 21, but flow was sufficient to allow migration over the dam only on June 28 and July 11. Sewage enters the pool formed immediately below the dam. The mud bottom is covered by a layer of sludge, which is only partly scoured out during high-water periods. Fishes were obtained at this station only under high-water conditions.

Boomer Creek, site of station "E", is a series of contiguous pools formed by low-water dams. Flowering plants, principally *Jussiaea diffusa* and *Lemna minor*, are abundant in many of these pools. Very little water-level fluctuation occurs, since Boomer Lake catches nearly all the runoff from the Boomer Creek watershed and rarely overflows. Thus the habitat is more akin to that of ponds than of streams. Frequent stocking, the different habitat, and partial isolation have left Boomer Creek's fish population at variance with that of other stations. In addition to differences in kinds and abundance of fishes (Table 1), the condition of the fishes taken was uniformly poor, whereas fish condition at other stations was invariably excellent.

Station "F", immediately below the Blackwell Lake dam, consisted of three different habitats: a concrete-lined outlet tunnel through the dam, a large pool below the tunnel apron, and the narrow stream channel below this pool. Boulders in the pool and the concrete apron at the tunnel mouth were covered with filamentous algae. A minimal flow was assured through a single lake outlet valve, which is jammed partly open.

The abundance of fishes at this station was never as great as at "A", and was less than that at "C" and "D" when there was sufficient dissolved oxygen

TABLE 1.—The per cent of total take per station and a comparison of abundance, in decreasing order (rank), with the 1938 survey. Species not taken but known to be present are indicated by "pr".

Species	Station "A"			Station "B"			Station "C"			Station "D"			Station "E"			Station "F"			Grand Total	
	% of total	rank	rank in 1938	% of total	rank	rank in 1938	% of total	rank	rank in 1938	% of total	rank	rank in 1938	% of total	rank	rank in 1938	% of total	rank	rank in 1938	% of total	rank
Lepisosteus osseus	0.04	23	—																0.02	31
Amphiodon alosoides		pr																		
Dorosoma cepedianum	6.05	5	11				0.22	16	—				0.43	17	—	0.60	13	—	3.30	8
Carpiodes (sp.)	6.92	4	6				0.29	15	—				2.17	10	—	0.67	12	—	3.85	6
Cyprinus carpio	0.02	27	—				0.11	18	—	0.08	15	—	0.22	18	—				0.05	26
Hybopsis storerianus	0.09	17	—																0.05	26
Extrarius aestivalis	4.74	6	10																2.48	11
Notemigonus chrysoleucas	0.04	23	—	0.45	7	—	0.58	11	—	0.53	10	—	8.26	6	—				0.54	19
Notropis percobromus	2.66	8	3				1.08	7	—										1.54	14
Notropis zonatus	one specimen from a pond, not tabulated																			
Notropis blennius	0.21	14	—																0.11	23
Notropis lutrensis	8.00	3	4	23.32	2	3	35.40	1	1	71.60	1	4	21.30	1	—	25.10	1	—	23.36	2
Notropis girardi	20.51	2	2																10.72	3
Notropis deliciosus	0.02	27	—	1.35	6	—				0.08	15	—							0.05	26
Notropis volucellus	0.06	20	—				0.72	9	—	0.15	14	—							0.15	21
Phenacobius mirabilis	0.02	27	—				0.07	19	—	1.88	6	—				3.53	8	—	0.78	18
Hybognathus placita	41.70	1	1	0.45	7	2	17.81	3	3	2.03	5	—	6.52	7	—				24.77	1

TABLE 1.—*(continued)*

TABLE 1.—(*continued*)

Pimephales promelas	0.17	15	—	13.00	4	1	2.09	5	4	9.62	2	—	5.65	8	—	12.32	3	2	3.95	5
Ceratichthys (sp.)	0.04	23	—				0.58	11	—	1.13	9	—				9.92	5	—	1.69	13
Hyborhynchus notatus										0.08	15	—							0.01	33
Campostoma anomalum										0.08	15	—							0.01	33
Ictalurus lacustris	3.87	7	—							0.38	12	—	1.52	14	—	2.86	10	—	2.56	10
Ameiurus melas	0.43	11	—	7.62	5	5	4.04	4	5	0.53	10	1	1.96	11	—	0.40	14	3	1.15	15
Ameiurus natalis				0.45	7	—	0.43	13	—										0.07	25
Pilodictus olivaris		.pr												pr						
Anguilla bostoniensis		pr																		
Fundulus notatus														pr	6					
Plancterus kansae	0.07	19	9																0.04	29
Gambusia affinis	2.08	9	—				32.73	2	2	4.73	3	—	8.48	5	—	10.19	4	—	7.99	4
Lepibema chrysops	0.37	12	—																0.19	20
Micropterus salmoides	0.06	20	—										1.09	15	3	0.07	16	—	0.09	24
Chaenobrytus coronarius													0.22	18	—				0.01	33
Lepomis cyanellus	0.31	13	5	34.53	1	4	1.59	6	6	1.88	6	3	1.74	12	2	5.19	6	1	2.21	12
Lepomis humilis	1.19	10	7	18.83	3	6	0.94	8	—	3.31	4	5	11.09	4	—	4.86	7	4	2.79	9
Lepomis megalotis	0.15	16	—				0.43	13	—	1.65	8	—	1.74	12	—	3.40	9	—	0.92	16
Lepomis macrochirus	0.09	17	8				0.65	10	7	0.23	13	—	12.39	2	1	1.20	11	—	0.90	17
Lepomis microlophus													0.87	16	—				0.04	29
Pomoxis annularis	0.06	20	—				0.22	16	—	0.08	15	2	11.96	3	4	19.44	2	5	3.44	7
Pomoxis nigro-maculatus													2.39	9	5	0.27	15	—	0.15	21
Aplodinotus grunniens	0.04	23	—																0.02	31

at the latter stations. Larger populations were found at "F", however, than could be expected in other habitats above the sewage outlets, in relation to its proximity to the source of escape of lake fishes, and to the concentration produced by the dam as a barrier to upstream progress.

Although the dam stops spawning migrations short of the intended destinations, there was no evidence that it inhibits spawning. Most, if not all, species find and utilize acceptable spawning sites in the varied habitat just below the dam.

ANNOTATED LIST OF SPECIES*

Lepisosteus osseus (Linnaeus).—Only two specimens of the longnose gar were collected, both at "A" December 18. This species is often reported, however, and may be common in the stream. Moore, Hughes, and Park took 70 pounds of gar in one day in a trammel net set near the mouth in February 1934.

Amphiodon alosoides Rafinesque.—Although no specimens were taken, the goldeye almost certainly occurs in Stillwater Creek. A single river specimen caught in April about a half-mile downstream from the creek mouth was identified by Delbert Taber, a fisheries student at Oklahoma A. & M. College. Another fish caught in May in Stillwater Creek was, from the angler's description, believed to be this species.

Dorosoma cepedianum (LeSueur).—(Max. 300). The gizzard shad, taken by Moore and Mizelle only at the creek mouth, where it ranked last in relative abundance, now occurs throughout the drainage system wherever the water is comparatively quiet and more than a few inches deep. It is abundant in the quiet waters at "A", but populations there fluctuate widely. Although less common upstream, specimens were taken at stations "C", "E", and "F", and dead individuals were observed at "D". The shad population reached its peak at "A" December 18, exhibiting a sudden increase for which an explanation is later proposed.

A few large shad (200 mm. and over) were consistently taken from two small pools in station "F" collections on and prior to January 8. This population disappeared between January 8 and March 18, however, and no shad were taken at "F" during the spring and summer.

Shad with developing eggs were first taken at "A" April 23. One larva, one postlarva, and two very young fry were caught May 27, when both the creek and the river were high and muddy. Young of the year (25-61, with the majority approaching the higher figure) were abundant at "A" July 5.

Carpiodes carpio (Rafinesque) and *Carpiodes velifer* (Rafinesque).—Both species were recorded by Moore and Mizelle. Of the 20 largest individuals (140-207) taken in the present survey, some obviously are *carpio*, whereas others show apparent *velifer* characteristics. However, the very close relationship between the two species and the high degree of variability evidenced by the specimens on hand convinced me that indisputable identification of every individual lies beyond my current capabilities. Since this was the case with the larger specimens, separation of the much more numerous young was not attempted. A comprehensive study of the status and diagnostic features of *carpio* and *velifer* in this region would seem highly desirable.

As would be expected under conditions of stabilized flow and sewage pollution, carpsuckers have become more abundant and have spread upstream since 1938. Specimens were taken at every station except "B", whereas Moore and Mizelle found these species only near the mouth. Juvenile *Carpiodes* were abundant in nearly every "A" collection, but the majority of those collected upstream were adults.

Young of the year (19-35) were first obtained July 5 at "A" (water temp. 28° C.)

* The figures in parentheses indicate size limits in millimeters.

and in Spring Creek. They were concentrated in the latter, where hundreds could have been taken.

Cyprinus carpio Linnaeus.—Although few specimens were taken, reliable evidence gathered from previous experience and fishermen reports indicate that the carp is common throughout the stream system. Fishermen often catch carp near the creek mouth and in Boomer Lake, where spawning individuals were observed in June. Blackwell Lake, possibly because of its youth, contains fewer carp. Single young of the year (70 and 64 mm.) were taken at "D" and "E", respectively, July 14 (water temps. 30° and 28° C.).

Hybopsis storerianus (Kirtland).—(64-90). The silvery minnow, which ranked eighth of thirteen species obtained in one collection near the mouth in the 1938 survey, is represented by only five adult specimens in the 1947-48 series. These five were taken from water three feet deep in two December collections at "A".

Extrarius aestivalis (Girard).—(24-42). The occurrences of this unique little minnow seem unaccountable. Three specimens were taken at "A" on November 6, 212 on December 4, 1 on December 18, and 1 on February 1. February 28, the next collection date, none could be found in the mainstream but 38 were caught in Spring Creek. Thereafter no specimen was taken anywhere in the stream system, nor were any found in the first series of collections (prior to November 6). Females taken February 28 had incompletely developed eggs, but it is not believed that spawning occurred in Spring Creek or in Stillwater Creek. A single pair of mature specimens was captured in the Cimarron River June 9 (water temp. 28° C.) in still, shallow water over a sand bottom near debris and large rocks. They were placed in a large tub in which the discernible habitat was simulated, but they refused to spawn. Hubbs and Ortenburger (1929a) state that *Extrarius tetranemus* (Gilbert) (=*E. aestivalis tetranemus*, the form taken in this survey) "obviously spawns in summer, for breeding adults only were taken July 1 whereas both young and adults were caught July 11."

Notemigonus chrysoleucas (Mitchill).—(Max. 112). The golden shiner, found only in pools at the headwaters of Stillwater Creek in 1938, inhabited all 1947-48 stations except "F". It was taken with regularity only at "E", where young of the year (16-24) were caught June 28. With few exceptions, specimens from the mainstream were juveniles.

Notropis percobromus (Cope).—(27-58). The plains shiner, recorded as *Notropis atherinoides dilectus* (Girard) by Moore and Mizelle (1939), was referred to *N. percobromus* by Hubbs (1945). This form ranked third in relative abundance at the Stillwater Creek mouth and first near the mouth of Little Stillwater Creek in the previous survey, but fell to eighth at this survey's station "A". It was found in greatest abundance at "A" December 18 when 64 specimens were caught, two and one-half times the next largest number obtained in a single collection.

Despite the apparent decrease in abundance since 1938, the plains shiner's range within the stream has been extended. Specimens were frequently taken at "C", which is five miles upstream from the first 1938 locality record. Gravid females were caught at "A" May 27, but no young of the year were found.

Notropis zonatus (Agassiz).—One 88 mm. male in low spawning coloration was found in a minnow rearing pond near Boomer Creek May 28. This pond was stocked in the spring of 1947 with fishes obtained from an Ozark stream in Arkansas.

Notropis blennius (Girard).—(34-55). The river shiner occurred only in station "A" collections made after March 25. Its scarcity in Stillwater Creek is surprising, since it is abundant in nearby streams. One gravid female was taken July 5 (water temp. 28° C.).

Notropis lutrensis (Baird and Girard).—(Max. 73). The red shiner was the most abundant species at stations "C", "D", "E", and "F", and was the dominant minnow in Spring Creek. The largest populations were always found at "C" and "D", where the sewage concentration was greatest. October 16, under high-water conditions, red shiners were found directly at the mouths of the sewage outlet pipes. November 20 the number taken at the sewage plant exceeded the total of all other specimens by seven times. How-

ever, under oxygen-deficient conditions December 5, *lutrensis* populations collapsed more rapidly and more completely than those of other "C" and "D" inhabitants.

Mature males were taken at "E" and "F" April 15 (water temp. 17° C.) and at "C" on April 22. The first females with developing eggs were found at "F" April 30. On May 15 only males were found at "D", but from mid-May through completion of the survey mature individuals of both sexes were taken in every collection. Young of the year were not found until July 5, when one 16 mm. specimen was collected at "D", and 15-19 mm. young were taken at "A" (water temp. 28° C.). Two 12 mm. young were caught at "F" July 14 (water temp. 25° C.). One 24 mm. gravid female was found, duplicating in size the smallest mature specimens reported by Hubbs and Ortenburger (1929b).

Notropis girardi Hubbs and Ortenburger.—(Max. 39). Extremely abundant at "A", the Arkansas River shiner was not found above the mouth of Little Stillwater Creek. It was taken only in shallow water over or near sand bottoms. Despite its restriction to "A" collections, such large numbers were taken there during the fall that it ranks third in totals for all species throughout the stream system.

The large populations at the creek mouth and in lower Spring Creek moved into the river between May 23 and June 6, and the species was rarely represented in subsequent creek collections. It seems certain that spawning occurs only in the river. Eggs were taken from the river May 27 and June 23. On neither occasion could any eggs be screened from creek water. On the latter date the creek carried almost as much water as the river and was very muddy, making it difficult to believe that fish could differentiate between the two flows. Nevertheless, not an egg was obtained from the creek, whereas every river haul produced them. Other attempts to secure eggs were unsuccessful April 8 and 9. Results of this survey parallel those of Moore (1944) in that eggs could be procured only in flood waters and most abundantly in situations of the highest turbidity.

Notropis deliciosus (Girard).—(24-39). Five specimens of the sand shiner were taken, all in the fall, from stations "A", "B", and "D".

Notropis volucellus (Cope).—(27-32). The mimic shiner was found in small numbers at "A", "C", and "D". A slight concentration occurred in early fall at the eddy formed where the Stillwater Creek flow struck backwater in the mouth of Brush Creek (station "C"), but only single individuals were taken after this group disappeared in December as result of oxygen deficiency. One gravid female was taken in Spring Creek July 5 (water temp. 28° C.).

Phenacobius mirabilis (Girard).—(Max. 84). The suckermouth minnow was taken, with one exception, only during spawning activity. The first record was procured December 12 at "F". February 28 the second specimen, with immature eggs, was found in Spring Creek. March 25 one was taken at "C" and 25 at "D", all in spawning condition (water temp. 14° C.). Strangely, none was collected against the low-water dam at "D"; the series was taken en masse between two brush piles 50 yards below it. The water occupied was quiet, and about two feet deep over a bottom of mud and sludge. These fishes were again found localized in this spot April 2, but a severe reduction of dissolved oxygen occurred on this date, and none could be recovered April 3. It seems probable that spawning was attempted, but failed.

April 30 five *Phenacobius* in spawning condition were collected at "F", and here again were found in a quiet pool well below the dam, rather than crowded against it. May 20 one fully gravid female was taken from a deep pool several hundred yards below the Blackwell Lake dam. Water temperatures had by this time reached 25° C. June 15, young of the year (18-28)—but no adults—were found in abundance at "F". They were scattered everywhere, but the majority were taken in shallow, running water. June 29 the largest young taken measured 31 mm.; by July 14 lengths of 41 mm. had been reached. The July 14 specimens occupied only the swiftest water available. The habitat sought by adults between spawning periods was not determined. Those individuals which spawned at "F" had to be residents of the portion of stream above the low-water dam at "D", since

flow over the latter was insufficient throughout the winter and spring to allow migration beyond "D".

Hybognathus placita Girard.—(Max. 72). More specimens of the plains minnow were taken than of any other species, largely because of its extreme fall abundance at "A". *Hybognathus* gradually decreased in abundance upstream, but occurred at all stations except "F". Creek populations are seasonal, being greatest during the fall, diminishing in winter, increasing in early spring, and markedly decreasing in late spring and summer.

The majority of my observations indicate that most if not all *Hybognathus* desert the creek to spawn in the river. Although early and extensive migrations took many individuals *approaching* spawning condition upstream as far as "D" and into tributaries, no fully mature specimens were taken in the creek system. Furthermore, populations markedly decreased at the advent of the spawning season (about May 1), and young of the year were taken only at "A" and in Spring Creek, both of which are subject to frequent invasions from the river. The absence of *Hybognathus* at "F" is at least prima facie evidence that the species does not spawn in Stillwater Creek. In view of this evidence, it seems surprising indeed that adults approaching sexual maturity migrated far up the mainstream and into mere gullies carrying runoff from heavy rains into minor tributaries. After one heavy spring rain a specimen was found in a gutter on the Oklahoma A. & M. College campus, involving a journey over not less than eight blocks of paved streets.

Young of the year (13 mm.) were taken at "A" May 27, and 18-40 mm. young were found at "A" and in Spring Creek July 5 (water temp. 28° C.).

Pimephales promelas Rafinesque.—(Max. 72). Like *Notropis lutrensis*, the fathead minnow progressively increases upstream as *Hybognathus placita* populations diminish. Nowhere, however, does *Pimephales* manifest the spectacular abundance so often achieved by the other two species. Its populations, though low, seem comparatively stable, the only large fluctuation encountered other than spawning concentrations at "F" being a large population at "D" November 20. On that date station "D" supported climax populations in the presence of enormous quantities of food and a sufficiency of oxygen. Population trends at "C" indicate that the fathead may be more tolerant of concentrated sewage than *N. lutrensis* or *H. placita*.

Spawning individuals were first taken at "F" April 15 (water temp. 17° C.). In contrast to *N. lutrensis*, females were found accompanying males from the first indication of spawning preparations. Spawning fatheads were subsequently taken at "A", "B", and "E", and spawning continued through mid-July, when the last collections were made. Young of the year were taken from the mainstream at the mouth of Little Stillwater Creek June 8, at "F" June 15, and at "B" June 28. Thereafter they were found at every station, and in nearly every collection. Young as small as 9 mm. in standard length were found at "F" July 14, whereas others had reached lengths of 32 mm. One 39 mm. tuberculate male, undoubtedly a late-spawned 1947 individual, was taken at "D" July 14.

Ceratichthys perspicuus (Girard) and *Ceratichthys vigilax* Baird and Girard.—The bullhead minnow was recorded by Moore and Mizelle (1939) as *C. vigilax*, now known as the parrot minnow. Publication of the *Ceratichthys* monograph (Hubbs and Black, 1947) made it apparent that representatives of this genus in Stillwater Creek drainage should be *C. perspicuus*. However, the true *vigilax*, native to the Red River drainage, was subsequently introduced into Stillwater Creek by way of the Federal Government's initial stock for Blackwell Lake. Thus both species are now resident in Stillwater Creek. Difficulties attendant on identification of non-breeding specimens and the frequent occurrence of hybrids that show transition between the parent species in diagnostic features necessitate treatment of the two forms under a single heading in this report. Upon the advice of Dr. Carl L. Hubbs, a detailed analysis of this problem is reserved for separate publication.

Ceratichthys was not taken in the 1938 survey, but was recorded on the basis of previous collections from Boomer Lake. Immature specimens were frequently taken in the present survey, most abundantly at "F", but also at stations "A", "C", and "D". Although normally less abundant than *N. lutrensis*, *Pimephales promelas*, and even some

centrarchids at "F", they became the predominant species there during their spawning period. High males and gravid females were taken first at "F" on June 15 (water temp. 24° C.) and again at "F" on June 29, and at "D" on July 14 (water temp. 30° C.).

Hyborhynchus notatus (Rafinesque).—One bluntnose minnow (42 mm.) was collected at "D" November 20. Moore has taken this species in nearby Cimarron River tributaries having rocky bottoms, but its presence in Stillwater Creek was not expected.

Campostoma anomalum Rafinesque.—One 85 mm. stoneroller was taken in the current at the base of the low-water dam at "D" November 20. Occurrences of the stoneroller in slowly flowing, turbid streams in this vicinity, though rare, are not unprecedented. This specimen may have been a migrant individual, but its introduction as a bait minnow is also a possibility. The location of its capture, however, makes it improbable that this fish came from either of the principal known sites of introduction—Blackwell Lake and the pond from which *Notropis zonatus* was procured.

Ictalurus lacustris (Walbaum).—Few species have increased more strikingly since 1938 than the channel catfish. Although *Ictalurus* was known to occur in Yost Lake (on Brush Creek) and in Boomer Lake, no specimens were taken in the earlier stream survey. In the present survey the total number taken exceeded that of *Ameiurus melas*, the only abundant catfish in 1938. *Ictalurus* was particularly abundant at "A", where fertile waters are assumed to have drawn their large population from the river. Channel catfish were frequently taken at "D" and "E", and were common at "F", apparently as a result of abundant food, stabilization of flow, and escape from Blackwell Lake.

Extensive upstream migrations of channel catfish were observed during highwater periods of June and July. One nine-inch specimen was found in a rain-filled street gutter 10 city blocks from Stillwater Creek June 27. Individuals were seen clearing the low-water dam at "D" July 11, and were reported to have jumped it after heavy rains in late June. A distinct increase was subsequently noted at "F" July 14, when large numbers of adults were seined from the outlet tunnel and the pool below Lake Blackwell.

Young of the year (11-14) and (22-26) were taken at "A" June 23 and July 5, respectively.

Ameiurus melas (Rafinesque).—Although fewer specimens of the black bullhead than of the channel catfish were collected, *Ameiurus melas* retained its dominance at all stations except "A" and "F". It had a clear-cut advantage in intermittent tributaries.

One 15 mm. young was taken at "A" June 23, and 22 young (17-28) were collected in Spring Creek July 5 (water temp. 28° C.).

Ameiurus natalis (LeSueur).—The yellow bullhead was infrequently taken in both surveys. Its populations did not seem to have been altered significantly by changed stream conditions.

Pilodictis olivaris (Rafinesque).—Although no flathead catfish were taken in this survey, the presence of the species was confirmed by hook and line catches. Several flatheads, the largest of which weighed 69 pounds, were caught in Boomer Lake during the summer of 1948, and 38- and 45-pound specimens were taken from Boomer Creek in July. Fishermen report occasional catches near the Stillwater Creek mouth. One young *Pilodictis* was seined near the creek mouth in the 1938 survey.

Anguilla bostoniensis (LeSueur).—No eels have been taken in surveys of Stillwater Creek, but fishermen report infrequent hook and line catches. One persistent fisherman reported having caught "three or four in the last year." Museum specimens taken from the Cimarron River within reasonable distance of Stillwater Creek leave little doubt as to the authenticity of these reports.

Fundulus notatus (Rafinesque).—The blackband topminnow has been observed in Boomer Creek. It was taken by Moore and Mizelle from the same locality.

Plancterus kansae (Garman).—The plains killifish does not seem to invade Stillwater

Creek proper to any extent, having been taken, even at the stream mouth, on only one occasion, when two specimens were collected. A large population is indigenous, however, in all but the lowermost part of Spring Creek. About the last quarter-mile of this stream has a mud bottom and supports few *Plancterus*. Above this region *Plancterus* becomes increasingly abundant as the ratio of riffles to pools, and consequently the comparative area of clean sand bottom, increases. It alone occupies this habitat. The population in Spring Creek apparently receives very little replenishment from the Cimarron River. Young of the year (12-19) were taken June 8 (water temp. 28° C.), while spawning was still in progress.

Gambusia affinis (Baird and Girard).—(Max. 49). The mosquito fish, taken by Moore and Mizelle only at the mouth of Brush and Little Stillwater Creeks, now thrives throughout the stream. Only *Hybognathus placita, Notropis girardi,* and *N. lutrensis* were taken in greater abundance. *Gambusia* is better able to survive periods of oxygen depletion than winter conditions in Stillwater Creek. It was less severely reduced by oxygen deficiency in December than any other species. Spring, however, found only occasional *Gambusia* surviving. These began sexual development about April 15, when water temperatures reached 16° C. May 13, females containing embryonic young were taken at "C" (water temp. 18° C.). Young of the year were first taken at "F" June 15 (water temp. 24° C.). Young were found regularly, as were adult females still bearing young, from that date through completion of the survey in midsummer.

Lepibema chrysops (Rafinesque).—The white bass, which has increased spectacularly over much of Oklahoma in recent years, has invaded lower Stillwater Creek in such numbers that it has become the most important sport fish there. In late fall and early spring, according to anglers' reports, catches of 30 to 40 per fisherman day are not uncommon. At least one fisherman is supposed to have caught 100 in an afternoon. "Bill" Walker of Ripley, a most persistent fisherman of the creek mouth and nearby segments of the river, states that such catches have been made only in the last two years, and that he had never seen this fish before 1946. Moore, however, took one specimen, not reported previously, near the mouth of Stillwater Creek in 1934.

Adults were taken by seining only at "A" and only in the period between December 18 and April 23. Young of the year (20-27) were taken at "A" June 9, and 36-52 mm. young were collected there July 5 (water temp., both dates, 28° C.).

The usual size reported by anglers is 10 to 14 inches, but occasional two- and three-pound specimens are caught.

Micropterus salmoides (Lacépède).—The largemouth bass, common in lakes and ponds throughout the drainage basin, is rarely taken in the streams. Only Boomer Creek maintains substantial black bass populations. One 16-inch specimen, taken June 29 at" F", was the only adult collected at any station other than "E". Black bass probably are caught less frequently by anglers in lower Stillwater Creek than any other sport fish present. Their scarcity is at least partly attributable to intolerance of sewage, which has limited the success of most centrarchids.

Schools of bass fry were found in Boomer Creek March 12. A single young (10 mm.) was taken at "A" June 9, and three (26-29) were found in Spring Creek July 5.

Chaenobryttus coronarius (Bartram).—One 31 mm. warmouth was collected at "E" October 23. Although this is the first official record of the species in the Stillwater Creek basin, it was known to have been stocked at various times in nearby lakes. Yost Lake, which was poisoned recently, yielded numerous small warmouths, almost none of which had attained edible size.

Lepomis cyanellus Rafinesque.—(Max. 175). The green sunfish, which ranked first or second in abundance at ten of the twenty 1938 stations, has relinquished its dominance at all stations except "B". Nowhere has it kept pace with the increases of other species. It is most abundant in intermittent Little Stillwater Creek, rarest in Boomer Creek, where it apparently is discouraged by an overpopulation of bluegills, and more common at "F" than

at any station below the sewage disposal plant. Green sunfish occurred at all stations, however, and considering the stream as a whole still outnumbered all other centrarchids except *Lepomis humilis*.

The first sexually mature specimen was taken at "F" May 20 (water temp. 25° C.). The smallest mature female taken is 47 mm. in standard length. Young of the year were found at every station, first at "A" June 23, and most abundantly at "B" June 28 (water temp. 25° C.).

Lepomis humilis (Girard).—(Max. 82). The orangespotted sunfish apparently is the most tolerant and consequently the most abundant of the stream's centrarchids. In contrast with *L. cyanellus*, it competes well with bluegills in Boomer Creek. Like *cyanellus*, it is most common in the shallow water and pools of intermittent tributaries. *L. humilis* probably has increased in abundance since 1938, but its rank considering all species has fallen off slightly.

High males and gravid females were first taken at "F" May 20 (water temp. 25° C.), and sexually-developed specimens were collected later at "A", "B", "D", and "E". The smallest spawner seined was 37 mm. in standard length. Young of the year (18-31) were taken at "A" July 5 (water temp. 28° C.), and at "E" and "F" July 14.

Lepomis megalotis (Rafinesque).—(Max. 113). The longear sunfish, not recorded in 1938, is well established throughout the mainstream, probably as a direct result of clearer water and stabilized water level. Its occurrence showed a rather unusual periodicity. Specimens were taken in nearly every collection made through December 5 and after March 25, but none were found at any station between those dates. Winter movements into deep holes and oxygen deficiency in early December below the sewage plant, coupled with late spring migrations (as compared with other *Lepomis*) probably account for their disappearance. Concentrations of spawning longear sunfish did not develop at "F" until July 14 (water temp. 26° C.), making them the last of the sunfishes to arrive there. The numbers taken there and at "D" July 14 ranked second only to *N. lutrensis*. No 1948 young were taken, but 18 mm. specimens were found in October 1947.

Lepomis macrochirus Rafinesque.—Although present throughout the stream system, the bluegill was scarce except in Boomer Creek, where it was extremely abundant. Only 30 specimens were taken in the entire survey exclusive of Boomer Creek collections, while several times that many were taken in one "E" collection October 23. Most Boomer Creek specimens were stunted, whereas the few taken in Stillwater Creek were in excellent condition. Moore and Mizelle found *macrochirus* only in the lower regions of Stillwater Creek (below the sewage plant) and in Boomer and Brush Creeks. Brush Creek, being intermittent, probably depends upon annual population replenishment from lower Stillwater Creek. The small numbers taken in lower Stillwater Creek in this survey, and their occurrence only under the most favorable conditions, must indicate a marked intolerance of sewage pollution.

Spawning preparations were first indicated at "F" April 30. Young of the year were taken in Boomer Creek July 14 (water temp. 27° C.).

Lepomis microlophus (Günther).—Four redear sunfish were taken in Boomer Creek. The species has been stocked in several nearby farm ponds and in Blackwell Lake in recent years, and has become well established.

Pomoxis annularis Rafinesque.—The white crappie has increased in abundance since 1938, largely as a result of stabilized flow and frequent escapes from Blackwell Lake. From October until March it was the prevalent species at "F", where 116 were taken in two consecutive seine hauls in a single pool. The swift current during a period in March when all of the lake outlet valves were open apparently swept this population downstream, and few returned after the valves were closed. Between November 25 and January 8, 139 white crappie were tagged and many of these were recaptured at subsequent fall and winter stations, usually in the same pool where released. Only two of these (tagged January 8) were recovered during the spring and summer.

Also common in Boomer Creek, the white crappie was scarce elsewhere, only eight having been taken at stations "A", "C", and "D" in the course of the entire survey. Three of these were young of the year seined at "A" July 11 (water temp. 28° C.). A single 30 mm. young was taken at "F" July 14 (water temp. 25° C.).

Pomoxis nigro-maculatus (LeSueur).—Black crappie were occasionally taken at "E" and "F". A 288 mm. specimen, by far the largest crappie collected, was seined at "F".

Aplodinotus grunniens Rafinesque.—Two young of the year (26-27), were taken at "A" July 5 (water temp. 28° C.). Hook and line catches near the creek mouth are not uncommon, and Moore took one drum on hook and line near the present station "F" site in the summer of 1946.

Hybrid Combinations

Lepomis humilis × *Lepomis megalotis*.—One specimen was collected at "D".

Lepomis cyanellus × *Lepomis macrochirus*.—One was taken at "E" and several have been caught from a pond in the Little Stillwater Creek basin. A male green sunfish and a female bluegill were seen spawning in a cutoff pool near "F".

Hybognathus placita × *Notropis girardi*.—One specimen, believed to be the first of this combination recorded, was taken at "A". A detailed treatment is reserved for separate publication.

Ceratichthys perspicuus × *Ceratichthys vigilax*.—This combination was briefly discussed in the annotated list of species.

Discussion

During October and November, 1947, the stream contained an abundance and variety of fishes several times greater than found in the 1938 survey; an abundance, in fact, far in excess of anything a stream of the character of Stillwater Creek could be expected to support under normal conditions. On one occasion two men standing on a concrete ledge below the low-water dam at "D" cast a ten-foot seine into the water below and netted a mixture of catfishes, sunfishes, and minnows totaling more than a thousand specimens. Catches of several hundred specimens in conventional hauls of the short seine were common occurrences at "A", "C", and "D" during this period. The abundance of fishes at "A" increased still more in December. Athough the fish populations above the sewage plant were exceeded by those below, catches at "F" averaged 50 to 100 specimens per haul. Even this indicated a marked increase over the 1938 productivity.

The extreme fall populations enjoyed apparent optimum conditions for growth and survival. Through early November, flow from Blackwell Lake's open outlet valves exceeded the sewage influx, diluting the latter and sweeping sufficient quantities through to the Cimarron River so that oxygen deficiency—the sole harmful effect of sewage noted in this survey—was prevented. About November 24 the lake valves were closed, with the exception of the one jammed valve which contributed little more than the amount removed by evaporation, etc., from the upper 16 miles of stream. Flow over the low-water dam soon ceased. The resultant concentration of sewage and fishes in the greatly reduced volume of water below the sewage plant soon depleted the dissolved oxygen to a point well below the fishes' minimum requirement. A half-inch rain December 3 possibly contributed to oxygen deficiency by muddying the

creek without raising its level, temporarily preventing photosynthesis by the formerly abundant algae. By December 5, with the water level three feet lower than in early fall, representatives of all common species were found gulping at the surface and dead on the bottom and banks at "C" and "D". Station "D" was almost immediately depopulated. Swarms of surfacing fishes, with *Hybognathus placita* and *Ameiurus melas* predominating, persisted at "C" for several days, though tests December 6 indicated an almost complete absence of dissolved oxygen.

The next collection at "A", December 18, produced surprising results. Jumping fish and a constantly rippled water surface served notice of a concentrated, extremely active population. Seining soon proved what observation had indicated: a tremendous influx of fishes, particularly the larger species, had taken place. Ninety-six channel catfish were taken in one haul with a ten-foot seine, along with lesser numbers of other species. Another haul produced 256 adult gizzard shad. Several white bass, the first of the survey, were taken. Every seining effort resulted in catches greater than anything previously accomplished at this station, with the exception that minnows were less common than in earlier collections.

Three days later minnows were concentrated in Spring Creek and presumably had been there at the time the concentration of large fishes in the mainstream was noted. Minnows were so abundant near the mouth of this brook, which was only three feet wide and two or three inches deep, that they were easily caught from the very clear water by hand. Disturbance of this population caused swarms of minnows to move into the mainstream of Stillwater Creek. Marked increase in the agitation of the water surface surrounding the mouth of the tributary coincided with such movements. When disturbance of the tributary was discontinued, the swarms quickly returned, and voluntary ventures into Stillwater Creek were minimal. Perhaps the spectacular increase in predatory fishes, particularly white bass and channel catfish, had driven minnows which survived their depredations into shallow niches, best exemplified by this tributary, which the predators could not enter.

Correlation of these developments is striking. The immediate depopulation at "D", the retarded kill at "C"--involving the *apparent* survival of several hundred individuals for at least four days despite severe oxygen deficiency—and the sudden increase in abundance at "A", where oxygen remained sufficient, might suggest that an explanation based on certain behavior patterns pointed out by Hubbs (1933) might be applicable. Hubbs stated that oxygen depletion often stimulates fishes to restless movements that carry them out of the danger zone. Forbes (1926) testified to the effectiveness of this stimulus in directing fish out of polluted regions. Hubbs (1933) also noted that some fishes can survive for a considerable time even in extreme deficiency by gaping at the surface.

Observations indicated, however, that this situation required an almost opposite explanation. Although a certain amount of downstream migration could very well have progressed undetected, the only movements noted in close observation of distressed fishes took them into shallow backwaters along shore.

Since such places contained little if any more oxygen than the mainstream, the fishes would seem to have incurred additional disadvantage. Furthermore, even highly successful movement from oxygen deficient regions could not have produced so great a concentration of large fishes as was apparent at the mouth December 18. The principal trend of migration must have been *into* Stillwater Creek from the Cimarron River. This, all things considered, would be the expected reaction. As the water level receded, causing oxygen deficiency upstream, the fertility and fish food production near the mouth increased correspondingly. Concurrently, river fishes may have encountered distinctly unfavorable conditions, the Cimarron having just acquired a strong current and high turbidity as a result of melting snows upstream. The river is at best of low productivity, and the imposition of sudden unfavorable feeding conditions in the fall, when fish populations are at their annual height, must stimulate searches for more productive habitats—such as lower Stillwater Creek provided. The gizzard shad and other current-repelled species felt additional necessity for deserting the river, and their departure undoubtedly influenced the movements of predatory species.

By December 29 the kill at "C" and "D" had run its course, reducing the fish population to numbers that could subsist on oxygen produced by photosynthesis. The outlet gates at Blackwell Lake were reopened January 1, returning the stream to its former optimum status. Intermittent ice cover and uniformly low water temperatures inhibited repopulation, however, until early spring. No fishes were found at "D" from the time of the kill until March 25, when water temperatures reached 13° C. Populations at both "C" and "D" increased rapidly from that date through April 3, when a second kill occurred, the Blackwell Lake valves having again been closed. No definite pattern such as developed in the December kill was observed in this instance. Creek populations still were low, and population pressure in the river was much reduced as a result of winter mortality. Spawning preparations further influenced the distribution of many species.

Several of the early invaders were fully or nearly ready to spawn. They could not, under existing conditions, progress upstream beyond the low-water dam at the sewage plant. Thus the spring kill had the additional harmful effect of preventing reproduction in a considerable stretch of stream including stations "C" and "D", between the dates April 3 and June 21, when heavy rains again raised the water level. Spawning would normally have been heavy in this region, particularly below the low-water dam. One species encountered, *Phenacobius mirabilis*, apparently migrates upstream as far as possible and then spawns only for a limited period, which in this instance fell at the beginning of the oxygen-deficient cycle. Thus the entire spawning effort of individuals that migrated up Stillwater Creek to the sewage plant was almost certainly unsuccessful.

Although the lake's valves remained closed after April 3, frequent rains maintained a high water level from June 21 to the end of the survey period. July 14, when station "D" was last visited, the abundance of fishes was about one-third that encountered in the fall, and upstream migration was still in progress.

A comparison of data from the 1938 and the present survey indicates that raw sewage emptied into Stillwater Creek has benefitted the fish fauna. Despite periods of almost complete depopulation, the abundance of fishes was, on the whole, much greater than that found by Moore and Mizelle. Sewage probably is more beneficial in this area than in some of those previously investigated. The colloidal clay characteristic of the region imparts such high turbidity to natural waters that actual productivity is kept far below the potential of clear water. Stream turbidity in the Southwest may run as high as 30,000 parts per million. Even standing water, illustrated by most farm ponds, often averages 100 parts per million of soil turbidity even after the roiling effects of runoff have ceased. Photosynthesis is much reduced, and food production suffers accordingly. Introduction of organic matter has been the most practical method of precipitating suspended soil particles in small central Oklahoma impoundments (Irwin, 1945).

Although minnows and rough fishes, principally the gizzard shad and carpsuckers, have profited most from the sewage influx, increased populations are also measurable in angling success. Very little fishing is done in the immediate vicinity of the disposal plant, but a progressive forgetfulness of the source of the stream's flow occurs among resident fishermen each mile downstream. Catches, consisting chiefly of white bass, channel catfish, black bullheads, flathead catfish, and carp, are materially greater than in the past, fishermen report.

Yet even here "pollution" as an enriching influence is subject to attack. Sludge deposition exceeds sludge removal; the eventual result could not be other than unfavorable conditions most if not all of the time. Were it not for Blackwell Lake and its flood control utilization, an uninhabitable situation would have preceded this survey. Furthermore, the current abundance of fishes is not entirely attributable to sewage effects. Blackwell Lake, through stabilization of flow and introduction of new forms, has contributed to the increase. Populations of the white bass, which has become the major sport fish, have no basis for comparison with findings of the 1938 survey. The transient schools of this species, though attracted into the mouth of Stillwater Creek by the abundance of forage fishes found there, increased independently of sewage influences. Finally, the large populations found under favorable conditions are, in a sense, artificial. They are not self-sustaining, but depend upon frequent replacement from external sources rather than completion of an uninterrupted series of life cycles by permanent residents. This may be considered an undesirable analytical basis, since sources of replenishment are ever present, and since a number roughly equal to the temporary creek populations might succumb to competition and other natural "balancing" forces if this avenue of dispersal were not open to them. Nevertheless, the fact remains that adjoining waters are also subject to possible pollution—the sources of dispersal affecting Stillwater Creek conceivably could be eliminated—in which case the creek would be permanently denuded of fish life.

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A New Parrot Fish of the Genus Xenoscarus From the Gulf of California

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While preparing a report on the wrasses collected by the Stanford Natural History Club expeditions to the Gulf of California, interesting collections of labroid fishes were made available to me by the California Academy of Sciences. They were obtained by the Steinhart Aquarium collector, Mr. Donald A. Simpson, at Bocochibampo Bay near Guaymas, Sonora, Mexico. Among this material were two scarids of an undescribed species of *Xenoscarus*. They represent the first record of this genus outside of Peru and the second known species of the genus.

The status and classification of *Xenoscarus*, and related Pacific genera, which comprise a group of Scaridae with a single row of scales on the cheek, are very inadequately known. This is especially true of the Central Pacific forms. Evermann and Radcliffe (1917) compared *Xenoscarus* with *Sparisoma* and *Scarichthys*, although it is obviously not particularly related to either of these two genera. *Xenoscarus* is most similar to the coastal species, *Cryptotomus xenodon*, and to the Hawaiian species of the genus *Cryptotomus* (e.g., *C. viridescens*.)

The fundamental and most useful characters in the classification of the parrot fishes with a single row of scales on the cheek appears to be in the dentition, which differs in every species and follows generic patterns. The dentition of *Xenoscarus* and *Cryptotomus* is shown in figures one and two in order to illustrate the similarities and differences between these two groups. It is evident from Evermann and Radcliffe (1917) that the dentition of *X. denticulatus* is much more similar to that of *Cryptotomus* than is that of *X. hubbsi*, n. sp. Unfortunately, *X. denticulatus* was not available for further comparison.

A key has been prepared to the genera and species of parrot fishes with a single row of scales on the cheek, as they are now understood. The primary grouping on the basis of cheek scales appears to be natural, although such a relationship has not been particularly stressed by other authors. A comprehensive, world-wide review of the parrot fish genera should be undertaken to establish the generic relationships.

Key to the Genera and Species of Scaridae with One Row of Scales on the Cheek

1a. Teeth in upper jaw coalesced ..... genus *Leptoscarus*
2a. No canines in upper jaw ..... *Leptoscarus vaigiensis* (Quoy & Gaimard).
2b. A row of projecting conical canines superiorly in upper jaw ..... *Leptoscarus coeruleopunctatus* (Rüppell).
1b. Teeth in the jaws anteriorly imbricate or separate.
3a. No fold across isthmus. Retrorse projecting canines present on sides of upper jaw.

4a. Dorsal spines flexible, slender ..... genus *Cryptotomus*[1].
4b. Dorsal spines strong and stiff ..... genus *Scaridea*.
5a. Eight external flaring canines, above imbricate incisors in upper jaw.....
..... *Scaridea octodon Fowler*.
5b. Only one pair of posterior canines on each side of upper jaw .....
..... *Scaridea zonarcha* Jenkins.
3b. A well-developed fold present across isthmus. No projecting canines in jaws
..... genus *Xenoscarus*
6a. 21 scales in a mid-lateral series extending onto caudal fin. Predorsal scales extending onto interorbital. Teeth in each jaw in three oblique series .....
..... *Xenoscarus hubbsi*, n. sp.
6b. 23 scales in a mid-lateral series extending onto caudal fin. Predorsal scales not extending onto interorbital. Teeth in each jaw in five or six oblique series ..... *Xenoscarus denticulatus* Evermann & Radcliffe.

Genus XENOSCARUS

Xenoscarus Evermann and Radcliffe, 1917, p. 129 (original description; genotype by original designation *Xenoscarus denticulatus* Evermann & Radcliffe).—Hildebrand, 1946, p. 354 (description).

This genus is previously known from a single species recorded only from Peru. Hildebrand altered several of the diagnostic characteristics of this genus and species as given by Evermann and Radcliffe: "gill membranes narrowly joined to isthmus" was changed to "gill membranes broadly united and attached to isthmus"; "four scales on median line of back in front of dorsal" was replaced by "three scales on median line in advance of dorsal." Furthermore, he does not mention the broad fold across the isthmus, which was considered to be very important by Evermann and Radcliffe. I have not seen specimens of *Xenoscarus denticulatus*, but plate 12, fig. 1 in Evermann and Radcliffe shows four predorsal scales for this species. Otherwise I have been unable to check the changes made by Hildebrand.

Xenoscarus hubbsi, n. sp.

Holotype: California Academy of Sciences number 20386; 66.5 m.m in standard length (measured from the tip of the snout to the base of the caudal rays); collected at the Inlet of Bocochibampo Bay near Guaymas, Sonora, Mexico, by Mr. Donald A. Simpson on January 2-4, 1946.

Paratype: California Academy of Sciences number 20387; 45.5 mm. in standard length; same locality and collector as holotype March 30, 1946.

Diagnosis.—This species is ascribed to the genus *Xenoscarus* on the basis of the following characters: the gill membranes are somewhat narrowly joined to

[1] The Pacific members of the genus *Cryptotomus* are in confusion despite the recent review of the Indo-Australian forms by de Beaufort (1940). Examination of the material of this genus in the Stanford Natural History collection leads me to believe that de Beaufort's combining of all south Pacific forms into one species (*Cryptotomus spinidens*) is not justified.

At present apparently five species are recognized in the Pacific: *C. japonicus* (Cuvier & Valenciennes), *C. viridescens* (Rüppell), *C. spinidens* (Quoy & Gaimard), *C. carolinus* (Valenciennes) and *C. xenodon* (Gilbert). De Beaufort doubtfully combines the central Pacific genus *Calotomus* with *Cryptotomus*. Further investigation probably will find *Calotomus* to be valid.

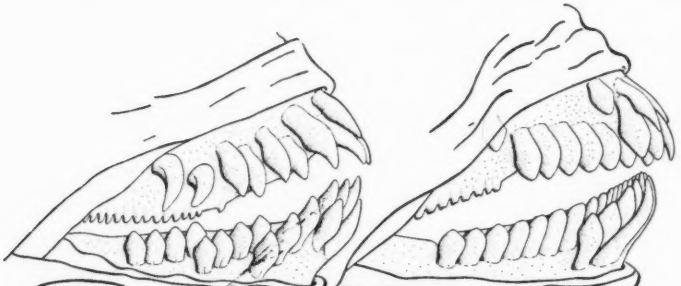
isthmus, across which they form a shallow fold. The upper lip is double its entire length, but the inner fold is not as well developed as in *Lepidocarus*. The inner fold projects beyond the outer fold laterally, but is approximately half the length of the latter at the symphysis. The lower jaw is included. The anterior teeth are distinct, imbricated in regular oblique rows on both jaws. Neither conical flaring teeth nor canines are present. There is one row of scales on the cheek. Dorsal spines soft and flexible.

The species is similar to *Xenoscarus denticulatus*, but is readily distinguished. The differences are: in head length (2.9 in *hubbsi*, 3.1-3.6 in *denticulatus*); in dentition (teeth in *hubbsi* in three oblique rows; all rows originating at symphysis; teeth in *denticulatus* in five or six oblique rows; all rows not having a common origin at the symphysis, being arranged along the sides of the dental plate); in predorsal scale position (anterior-most predorsal scale extending onto interorbital, not extending onto interorbital in *denticulatus*); in number of scales (21 scales in a mid-lateral series, versus 23); in size of the last mid-lateral scale (its exposed part much longer than penultimate mid-lateral scale, versus shorter than penultimate scale); and in markedly different coloration.

Description.—The measurements and counts for the holotype are given first, followed by those for the paratype in parentheses. The measurements have been mathematically divided into the standard or head length as indicated.

Body moderately deep and robust; greatest depth in region of pelvic fins, 2.8 (3.3) in standard length. Caudal peduncle from end of dorsal base to mid-base of caudal, 2.2 (2.2) and its depth 2.3 (2.4) into head length. Anus not advanced in position.

Head compressed, its length 2.9 (2.9) into standard length. Profile of snout evenly rounded to interorbital; a slight hump on nape. Snout length



Figs. 1, 2.—1. Dentition of a specimen of *Cryptotomus viridescens* (Rüppell) from the Hawaiian Islands (Stanford University number 3244); 2. Dentition of the holotype of *Xenoscarus hubbsi*.

3 in head length. Nostrils near upper anterior border of eye. Anterior nos ith a raised rim and an elongate flattened lappet on its posterior margin. osterior nostril with a slightly raised rim, which is almost slit-like at its anterior margin. Bony orbit round, 4.1 (3.9) in head length. Posterior margin of orbit at middle of head length. Interorbital width 4.0 (4.1) in head. Inner upper lip developed along its entire length, covered by the outer lip, except laterally. Inner upper lip at symphysis half the length of the outer fold and crenulated along its free border. Fold of lower lip developed laterally only. Jaws subequal, lower jaw distinctly included. Lateral teeth of upper jaw co-

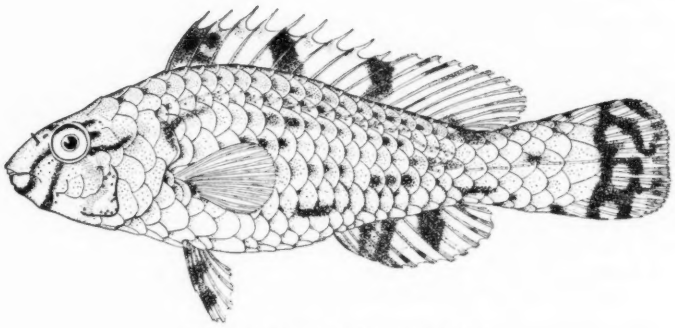


Fig. 3.—Holotype of *Xenoscarus hubbsi*.

alesced into a dental plate, its edge forming a lamina with a denticulated free edge in which 8 individual teeth are discernible. The dental plate not reaching the symphysis, but confined to the sides of the jaw. Anteriorly, dental plate hidden by three outer oblique imbricate series of broad, flattened incisors, the innermost series forming the cutting edge. No median notch on jaws. Teeth in lower jaw similar to those in upper with a single series of partly coalesced teeth laterally, and three series of imbricate teeth anteriorly. Teeth light, the dentary plate and innermost teeth of both jaws edged with brown. Gillrakers slender and weak 3+8 (4+9), their length approximately half that of pupil. The uppermost raker on first arch bifid in holotype, otherwise all rakers simple. Gill membranes somewhat narrowly attached to isthmus, with a shallow, free fold across isthmus. Branchiostegal rays 5+5.

Scales on cheek in one series of four scales, extending forward to below nostrils. Operculum fully scaled in three series. Scales 18-19 along upper branch of lateral line. Lower branch of lateral line beginning one scale row before end of upper, and with seven scales, including those extending onto caudal fin. Six scales from base of anal fin obliquely forward to lateral line. One and one-half scales above upper branch of lateral line. Scales on belly not reduced, three between isthmus and base of pelvic fins; two additional median scales extending onto pelvic fins. Predorsal scales four, extending onto interorbital; the posterior scale deeply notched to receive the first dorsal spine. Last caudal

scale much longer than preceding scales, its length 2.6 (2.5) in head (measurement III of Parr, 1930), this length less than distance from tip of scale to end of median caudal ray. Last median lateral scales well developed, rounded, slightly shorter than last caudal scale. The caudal scale measurements have been made according to the method of Parr (1930, p. 97).

Dorsal fin IX, 11; the last two rays split to the base, and counted separately. Dorsal origin anterior to opercular margin and pelvic fin origin, over base of pectoral fin. The dorsal spines of almost equal length, weak and flexible; longest spine 2.5 (2.4) in head length. Each spine continues as a short thin filament or lappet. Longest soft ray 2.1 (2.6) in head. Distance from tip of snout to dorsal origin 3.0 (2.3) in standard length. Dorsal base length 1.7 (1.8) in standard length.

Anal fin III, 10; the last two rays split to base and counted separately. Anal origin under first or second dorsal soft ray. Longest anal soft ray 2.4 (3.0) in head length. Distance from tip of snout to anal origin 1.5 (1.7) in standard length. Length of anal base 3.6 (5.5) in standard length.

Pectoral fin rounded; the upper angle acute, the lower angle rounded. Pectoral fin with two simple upper rays and eleven bifid rays, the first bifid ray being the longest. Length of pectoral fin 1.9 (1.9) in head length. Pelvic fin I, 5, the spine two-thirds the length of the first ray; second soft ray the longest. Length of pelvic fin 1.9 (2.1) in head length.

Caudal fin slightly notched or rounded, almost truncate, with 11 principal rays. Length of caudal fin (measurement IV of Parr) 2.8 (2.8) in standard length.

Measurements in Percent of Standard Length: Body depth 35.5 (30.8); caudal peduncle length 15.2 (15.3); caudal penduncle depth 14.6 (14.3); head length 34.2 (33.7); snout length 10.0 (10.5); rictus length 7.9 (7.0); orbit length 8.2 (8.3); interorbital width 8.4 (8.1); snout to dorsal origin 33.3 (34.1); dorsal base length 60.3 (56.6); longest dorsal spine length 13.5 (14.0); longest dorsal soft ray length 15.9 (13.2); snout to anal fin origin 63.7 (60.1); anal base length 27.5 (26.6); longest anal soft ray length 13.9 (11.4); pectoral fin base width 6.6 (6.8); pectoral fin length 18.0 (17.1); snout to pelvic fin origin 35.5 (37.0); pelvic fin length 17.7 (16.5); caudal fin length from mid-base of rays to tip of longest lateral rays 27.0 (27.7); caudal fiin measurement I 13.9 (13.1); caudal fin measurement II 8.4 (8.9); caudal fin measurement III 13.0 (13.7); caudal fin measurement IV 35.4 (35.4).

Coloration.—The coloration of this species is remarkably similar to that of *Leptoscarus vaigiensis;* for example as shown by Bleeker (1862, pl. 1, fig. 3). The coloration of the holotype preserved alive in formalin and transferred to alcohol: general ground color light greenish-brown with darker brown small blotches and spots tending to form longitudinal streaks; head with seven oblique bars radiating from the eye; vertical fins strongly marked; dorsal fin with three broad conspicuous blotches; the first dorsal blotch on the membranes between the first three spines; the second between the fifth and seventh spines; and the third blotch between the last dorsal spine and the third soft ray; median dorsal soft rays with brown spots; anal fin with three dark vertical blotches; caudal fin

vertically striped and blotched; pelvic fins with three broad oblique bands; pectoral fins hyaline, a spot on the base of the median rays.

Coloration of paratype: this specimen is more contrastingly marked with the brown, the dark brown blotches being much more distinct than in the holotype. The pattern is similar, except that there is an additional band from the anterior border of the eye toward the snout, and the caudal fin does not have vertical streaks. Instead, the caudal fin has one large irregular blotch and two small posterior blotches.

Dr. Carl L. Hubbs of the Scripps Institution of Oceanography pointed out that this species was undescribed when he examined the Guaymas material of Mr. Donald A. Simpson, when the latter stopped at Scripps on his way home. I take pleasure in naming this species *Xenoscarus hubbsi* in honor of Dr. Hubbs.

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Taxonomy, Nomenclature, and Distribution of Southeastern Cricket Frogs, Genus Acris

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The two cricket-frogs, *Acris crepitans* Baird and *A. gryllus* (LeConte), are now being listed as separate and valid species. However, the question of their distinctness has been reopened by the description of *A. g. blanchardi*, which exhibits some characters reminiscent of *crepitans* (Harper, 1947, Proc. Biol. Soc. Wash. 60: 39), and by an account of some Indiana *crepitans* displaying certain *gryllus*-like features (Mittleman, 1947, Amer. Midl. Nat. 38: 471). Accordingly it seems desirable to examine southeastern material in the light of various criteria that have been proposed to distinguish the two species (Dunn, 1938, Proc. Acad. Nat. Sci. Phila. 90: 153).

Two forms of *Acris* are found in east-central Georgia. One, an upland form, consistently displays a squat, rather toad-like build, a blunt snout, and a single, diffuse or irregular postfemoral stripe; the other, a lowland form, is slender, with a sharp snout and one or two sharply defined postfemoral stripes. The former I consider to be *crepitans*, the latter *gryllus*. The upland type ranges in eastern Georgia southward to about 45 miles below the Fall Line in upper Emanuel County; the lowland form extends northward in eastern Georgia to about 60 miles above the Fall Line in Clarke County. Thus the respective ranges of the two overlap for a distance of perhaps 105 miles.

For this survey I selected (on the basis of head shape, build, and postfemoral striping) 200 *crepitans* and 200 *gryllus*, all sexually mature, both series equally divided as to sex, and all from Richmond and Burke counties, Georgia.

In this series the average snout-vent length of *crepitans* males was 21.6 mm., of *gryllus* males 21.5 mm.; of *crepitans* females 24.0 mm., and of *gryllus* females 22.1 mm. The largest *crepitans* was a female of 27.7 mm., the largest *gryllus* a female of 25.5 mm.

The extension of the heel of the appressed hind limb, whether reaching beyond the snout or not, is at best an unsatisfactory criterion, since it is affected by the contour of the side of the body, and this in turn is modified by many factors. In 30% of the *crepitans* females the heel just reached the tip of the snout; in the remaining 70% it extended beyond the snout. Likewise, in 30% of the *gryllus* females the heel barely reached the tip of the snout, extending beyond the snout in the remaining 70%. The heel extended beyond the snout in all males, both *crepitans* and *gryllus*. The maximum extension of the heel beyond the snout was found in *gryllus*.

In all the males of both species, the third and fifth toes reached at least to the middle of the third phalanx from the tip of the fourth toe. In *crepitans*

females the extension of the third and fifth toes ranged from slightly beyond the middle of the third phalanx to the base of the second phalanx from the tip of the fourth toe. In *gryllus* females the third and fifth toe failed to reach the middle of the third phalanx in 31% of the specimens, just reached the middle in another 31%, and extended beyond the middle in the remaining 38%.

In 42% of the *crepitans* females about 2¼ phalanges of the fourth toe were free of web, in 51% about 2 phalanges were free, and in 7% slightly less than 2 phalanges were free. In 9% of the *gryllus* females about 2¼ phalanges were free, in 11% about 2½ phalanges free, and in 80% almost 3 phalanges were free of web. In all the *crepitans* males there were about 2 phalanges free; in 27% of the *gryllus* males there were slightly less than 3 phalanges free, and in the remaining 73% fully 3 phalanges free of web. The first toe was half to three-quarters webbed in males of both species; half to completely webbed in *crepitans* females, and half to three-quarters webbed in *gryllus* females.

Both species displayed a pair of enlarged anal warts, usually with many smaller warts below them. In *crepitans* the maximum diameter of the large warts ranged from 1.5 to 0.7 mm., in *gryllus* from 1.0 mm. to completely lacking. The dorsum of *crepitans* bore many enlarged warts or raised areas; these were generally less evident in *gryllus*. However, large female *gryllus* were as warty as any *crepitans*.

In both sexes of *crepitans* the back of the thigh was marked with an irregular black stripe and, below this, an indistinct black stippling suggesting a second stripe. In 3% of the *gryllus* females the same pattern was displayed; in all the remaining *gryllus*, both sexes, the upper stripe was narrow and sharply defined, the lower stripe ranging from a vague stippling (22% of total *gryllus* specimens) to a well defined, regular line (in 10%).

In life *crepitans* was usually pale gray, with darker spots and a yellowish suffusion about the hind limbs; occasionally a green vertebral stripe was developed. Living *gryllus* usually displayed a bright green, yellow, chestnut or deep red vertebral stripe, this stripe often forking on the head and extending to each eye. The ground color of *gryllus* was usually dark brown or black; in some localities most specimens were uniformly suffused above with black.

In both sexes of *crepitans* the body was rather stout, the snout bluntly rounded, the toes proportionately stout; in all *gryllus* the body was slender and graceful, the snout sharply pointed, the toes long and slender.

To summarize the situation in the area under consideration, it may be stated that the snout-vent length, the extension of the heel beyond the snout, and the length of the third and fifth toes are useless as criteria; the extent of the webbing of the fourth and of the first toe, the size of the anal warts, the degree of wartiness of the dorsum, and the coloration of the dorsum in life are useful criteria when series are at hand; the body build, the shape of the snout, the stoutness of the toes, and the nature of the postfemoral striping are the best definitive characters.

Since the frogs were originally divided into two groups on the basis of certain characters, it is obvious that the above statement actually reflects the

correlation of other characters with the ones used in the division. However, the resultant *crepitans* group agrees closely with series taken much farther north, beyond the range of *gryllus*; and conversely, the *gryllus* group agrees closely with series collected farther south, beyond the range of *crepitans*. Accordingly, it is felt that the original separation was natural and not arbitrary, particularly since the resultant groups are also characterized by difference in range, habits, voice, and larval structure.

A combination of all useful characters will readily distinguish 99% of the specimens examined. Four examples, all females, displayed the following characters: 2½ phalanges of the fourth toe free from web; first toe three-quarters webbed; anal warts tiny; dorsal warts prominent; dorsum gray with a green vertebral stripe; body slender; snout pointed; toes stout; postfemoral stripe one, broad and irregular. These aberrant specimens were taken at scattered localities where both *gryllus* and *crepitans* were present. Not improbably the intermediate examples are hybrids. The occurrence of rare, scattered intermediates does not invalidate the premise that *gryllus* and *crepitans* are separate species. Occasional hybridization of related species is known in many genera, particularly in areas where ecological niches merge.

In the Fall Line region the two species are often collected together. They frequently breed together in approximately equal numbers about many ponds in Richmond County, Georgia. It is surprising that they do not more frequently hybridize. The calls of the two are similar, but can be distinguished when both are heard together. The call of *crepitans* is a series of loud, sharp clicks; *gryllus* utters a series of notes neither so loud nor so sharp, each note with more of a buzzing or vibrant quality. The call of *crepitans* has been aptly likened to the sound of two marbles being struck together repeatedly; that of *gryllus* might be compared with the sound produced when two hard, roughened surfaces are repeatedly scraped together.

It is interesting to note that *Acris crepitans*, *A. g. gryllus*, and *A. g. dorsalis* display different types of escape behavior. *Crepitans* usually sits motionless when approached, and can readily be seized by hand. If disturbed, it often hops but once and can be closely approached again. *Acris gryllus* may often hop before the collector is within range; at such times it makes first a single long leap and then, in the concealment of reeds or grass, a second, shorter hop. If frightened by an unsuccessful "grab" it makes off in a long series of leaps. If chased into the water, it tends to sit on the floating debris or vegetation, apparently relying on coloration for concealment. If further pursued it may submerge and hide beneath debris on the bottom. The subspecies *dorsalis*, when disturbed, begins a remarkable series of erratic, bewildering leaps and then suddenly dives into the water to disappear beneath trash or mud on the bottom .A good collector can catch practically all *crepitans*, but will miss quite a few *gryllus* and a great many *dorsalis*.

While collecting near Jacksonboro, Colleton County, South Carolina, I noticed some cricket-frogs that behaved exactly like Florida *dorsalis*. Twelve specimens were secured which, in the field, seemed identical with cricket-frogs taken a few days before in northern Florida. It therefore seems desirable to investigate the relationship of *A. g. gryllus* and *A. g. dorsalis*. For this pur-

pose I have utilized the 200 *gryllus* mentioned above; 50 *gryllus* from Emanuel County, Georgia; 23 topotypes of *gryllus* from Liberty County, Georgia; 24 *gryllus* from Allendale County, South Carolina; 12 topotypes of *dorsalis* from Nassau County, Florida; 30 *dorsalis* from Alachua County, Florida; and the 12 specimens from Colleton County, South Carolina.

The diagnostic features of *A. g. dorsalis* are stated to be: 2 dark postfemoral stripes; no anal warts; toes very slender and delicate; size very small, females seldom exceeding 20 mm. snout-vent length (Netting and Goin, 1945, Journ. Fla. Acad. Sci. 8: 304).

The mere presence of two postfemoral dark stripes is by no means diagnostic. Netting and Goin mention that this pattern is developed occasionally in topotypes of *gryllus*, and is even more frequently encountered in specimens from extreme southern Georgia (*op. cit.*: 306). As a matter of fact the pattern is of frequent occurrence in populations of *gryllus* even as far north as the Fall Line, being present in 10% of the specimens from Richmond and Burke counties, Georgia. Furthermore, but one stripe is present in occasional specimens from central Florida. Netting and Goin's figure of the postfemoral pattern of *dorsalis* (*op. cit.*: pl. 1, upper) to me appears to be a good representation of the pattern of a large precentage of *gryllus* from the upper Coastal Plain; their figure of the pattern of *gryllus* (*ut supra*: center) is atypical of the form as I know it, somewhat suggesting *crepitans*; the figure of *crepitans* (*ut supra*: lower) portrays a fainter and more diffuse postfemoral stripe than is present in most Georgia examples of the form. Speaking generally, the inferior postfemoral stripe is more frequently developed and better defined in Florida than in Georgia examples; but there is considerable overlap in this character. In 10 of the 12 Jacksonboro, S. C., specimens the postfemoral pattern is indistinguishable from that of typical Florida *dorsalis*; the pattern of the remaining 2 is duplicated in several specimens from Alachua County, Florida.

Anal warts are lacking in 28% of *gryllus* specimens from the upper Coastal Plain of Georgia. They are lacking in 10 of the 12 Jacksonboro specimens; and only a single tiny wart is present on each side of the vent in the remaining 2 from this locality. Anal warts are lacking in all my Forida specimens.

The toes of *dorsalis* are very slender and delicate, more so than in Georgia *gryllus*, but not more so than in the Jacksonboro examples. The average snout-vent length of *gryllus* has been noted above; it considerably exceeds the average for *dorsalis*. The Jacksonboro females, 8 in number, average 18.9 mm. snout-vent length, range 16.4-21.4 mm. This is small for *gryllus*, but perhaps a little large for *dorsalis*.

I can not agree with the statement that "specimens of *gryllus* rarely exhibit an anterior bifurcation of the dorsal stripe" (Netting and Goin, *op. cit.*: 305). A bifurcate dorsal stripe is common in *gryllus* from the upper Coastal Plain, in some localities being the usual condition. *Gryllus* exhibits many localized variations. Specimens from one locality may consistently display a bifurcate green stripe and two postfemoral bands; those from a locality but a few miles away may invariably be marked with an unbranched red vertebral stripe and but one postfemoral band; a third nearby locality may produce only individuals with a blackish suffusion, etc.

On the whole, a combination of characters will serve to identify most specimens as either *gryllus* or *dorsalis*; and accordingly I feel that the latter is a valid subspecies. Specimens in my collection indicate that *dorsalis* displays an even more slender form and more sharply pointed snout than *gryllus*. Moreover, there is a voice difference, the notes of *dorsalis* being weaker and more buzzing or insect-like. The allocation of the Jacksonboro specimens, however, remains a problem. Ten of the twelve specimens are truly *dorsalis*; the remaining two are very close to that form. Perhaps the subspecies extends northward in a narrow strip along the Georgia and South Carolina coast. Duplication of the characters of Florida races in coastal Carolina populations is a common circumstance, occurring in *Pseudotriton montanus flavissimus*, *Natrix sipedon fasciata*, and other species.

It has recently been suggested that the cricket-frog of the Atlantic Coastal Plain be called *Acris ocularis* (Mittleman, 1946, Herpetologica 3: 57). This contention is based on the name *Hyla ocularis*, the description of which has been attributed to Bosc and Daudin. (*in* Sonnini and Latreille, 1801, Hist. Nat. Reptiles, Deterville ed., 2: 187). However, others have considered the name unidentifiable, or applicable to the frog generally known as *Pseudacris ocularis* (Holbrook) (cf. Brandt and Walker, 1933, Occ. Pap. Mus. Zool. Univ. Michigan 272: 2). The description is highly ambiguous and almost certainly composite. Bosc in Charleston may have had *P. ocularis*; Daudin in France may have confused the form with *A. gryllus*, *A. crepitans*, or some other frog in the Museum d'Historie Naturelle (Daudin, 1802, Hist. Nat. des Rainettes, etc., folio ed.: 22 *et seq*). Daudin's figure (*op. cit.*: pl.. 20, fig. 2) is considered by Mittleman to represent *Acris gryllus* (cf. Mittleman, *op. cit.*: fig. 1). He states that Daudin's plate "clearly shows a blunt-headed frog which is in marked contradistinction to the prominently pointed and long-snouted *P. ocularis*". However, Harper's photographs of *Pseudacris ocularis* show an animal with a snout much like that portrayed by Daudin (Harper, *op. cit.*: figs. 3-4). Certainly the snout of *Acris gryllus* is sharper than in Daudin's figure. A black band extending backward from the eye along the side is characteristic of *P. ocularis*, not *A. gryllus*; and the digital disks are much too large for a cricket-frog. To my mind, the body build, head shape, pattern, webbing, and digital disks suggest a young *Hyla squirella* more than anything. The figure could pass for a young *Pseudacris ornata* but for the extent of the webbing. In any event, the figure did not accompany the original description.

Further discussion is pointless. Obviously neither description nor figure is definitive; the name is an unrecognizable composite. I accordingly support the retention of the name of *Acris gryllus* (LeConte) for the cricket-frog, and of the name *Pseudacris ocularis* (Holbrook) for the little tree-frog. The generic allocation of the little tree-frog, whether *Pseudacris* or *Hyla*, is of course a taxonomic problem, and beyond the scope of this paper.

Amphibians and Reptiles of Brazos County, Texas

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Faunal surveys have been carried on in but a few scattered counties in Texas. Brazos County, situated in southeastern Texas, represents a part of the state from which very few records of amphibians and reptiles appear in the literature. Only two or three records are known from the county itself. In this county, studies of the avian and mammalian fauna made by Davis (1940) and Peterson (1946) indicate that it is within an area of differentiation of many species of birds and mammals. Preliminary studies indicate that such differentiation also occurs in the amphibians and reptiles.

A total of 60 different forms are recorded from the county divided as follows: salamanders, 4; frogs and toads, 14; alligators, 1; lizards, 9; snakes, 23; turtles, 9. Over 1500 specimens from Brazos County have been examined and 14 additional species are recorded from adjacent counties.

A number of range extensions are pointed out in addition to several life history and systematic notes. These records are based on investigations carried out in 1941-42 and 1946 while associated with the Department of Biology and the Department of Fish and Game of the Agricultural and Mechanical College of Texas, College Station, Texas.

Acknowledgements

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Description of the County

Brazos County, typical of the greater post oak belt, has an area of approximately 600 square miles. The general elevation ranges from 200 to 400 feet above sea level, the surface sloping gently toward the southeast. The topography is level to gently rolling, with no deep stream dissection or conspicuous topographical relief. Two distinct vegetative types, the uplands and the river and creek bottoms, are present, the former comprising about 75 per cent of the area and the bottomlands about 25 per cent.

The soils of the county may be placed in three general groups; forest soils, which are fine sandy loams for the most part; prairie soils, which are predominately clay loams and recent alluvial soils, most of which are clays.

The average annual precipitation is 38 inches; April and May are the months of heaviest rainfall. Droughts are common in summer. The mean annual temperature is about 65° F, the extremes ranging from about 10° to 110° F.

More detailed accounts of the geological and ecological relationships found within the county are given by Peterson (1946).

AMPHIBIANS

Triturus viridescens louisianensis (Wolterstorff), Louisiana Newt.—Occurs rather generally throughout the county. Most of the specimens taken have been of the land form, occurring under logs and other debris. Specimens were examined from 5 miles north, 2 miles northeast, and 10 miles southeast of College Station.

Ambystoma texanum (Matthes), Texas Salamander.—The most common salamander found in the county. A representative series has been collected in recent months. I have taken specimens from 10 miles east southeast and 5 miles southwest of College Station.

Ambystoma tigrinum tigrinum (Green), Eastern Tiger Salamander.—Four larval specimens collected near College Station, October, 1940, seem referable to this species. *A. t. tigrinum* is quite rare in the county, possibly as a result of the introduction of fish in most of the small ponds where normally this form might be found.

Siren intermedia nettingi Goin, Texas Dwarf Siren.—Occurs rather commonly in small ponds and sloughs. Several specimens have been taken 5 miles west and 1 mile northwest of College Station.

Scaphiopus hurterii Strecker, Hurter's Solitary Spadefoot.—Over a hundred specimens were taken between 4 and 7 miles southwest of College Station on March 12 and 13. Their distribution seems rather spotty in the county, apparently restricted to areas adjacent to favorable breeding ponds in temporary waters. No evidence of intergradation with *S. holbrooki* was found, and the tadpoles also appeared quite typical.

Bufo compactilis speciosus Girard, Spadefoot Toad.—A single specimen was taken 6 miles southwest of Millican, March 23, 1946, by B. C. Brown. One specimen was also collected in adjacent Burleson County.

Bufo valliceps Wiegmann, Mexican Toad.—Occurs rather widely throughout the county. I have taken six specimens in College Station, of which some are rather large, similar in size to *Bufo woodhousii*, and appear quite distinctly different from specimens taken in Orange County, Texas, near the coast.

Bufo woodhousii Girard, Woodhouse's Toad.—Apparently Brazos County is within an area of intergradation between two forms of this species. Large series taken throughout the county exhibit intermediate characters as described for both *B. w. woodhousii* and *B. w. fowleri*. Some specimens seem referable to one form and some to the other while certain specimens appear intermediate. A few individuals show certain characters similar to those of *B. americanus*, although the many calls heard throughout the spring attest the absence of this species. Those heard were uniformly typical of *B. woodhousii*. The question of subspecific identity of these specimens, however, requires additional study. I have taken several at College Station.

Acris crepitans Baird, Cricket Frog.—A very common frog occurring over all the county.

Pseudacris clarkii (Baird), Clark's Striped Tree Frog.—The first records of these frogs in this part of the country were made by collecting specimens in Burleson County 12 miles southwest of College Station at which time the calls were noted to be quite distinct from those of *P. n. triseriata*. No calls were heard in Brazos County until March 25, at which time specimens were secured from 8 miles west of Bryan. At this time their distribution seemed to be restricted to the clay soils where they were found in both Brazos and Burleson counties. It was not until about May 18 that calls were noted in the sandy soils in the vicinity of College Station; a specimen was then secured 1 mile north of there and additional calls were noted in various localities between Bryan and College Station. Such late emergence of specimens occurring in sandy soil areas is of considerable interest. We

have at present no plausible explanation. All specimens secured were taken from small shallow temporary pools of watre that were filled with grass and other vegetation.

Pseudacris nigrita triseriata (Wied), Striped Cricket Frog.—This species was one of the most common frogs heard calling from ponds throughout the county in early February, and calls have been heard throughout May. I have examined specimens from many county localities and have taken them commonly 5 and 8 miles southwest of College Station.

Pseudacris streckeri Wright and Wright, Texas Ornate Chorus Frog.—Survey of frogs calling in early February indicated that this form is very abundant in the entire county. I took a large series 5 miles southwest of College Station on March 12 and 13, 1946. The species is not heard, however, as warm weather approaches; the last date in which calls were recorded is March 13.

Hyla cinerea cinerea (Schneider), Green Tree Frog.—Occurs widely in the county where a favorable habitat is found of reeds, rushes or similar vegetation growing in bodies of water. A series of ten specimens were examined from 10 miles east southeast of College Station collected May 18 and 20, 1946. It is a late emergent which, while taken as early as February 21, was not heard in chorus until the middle of May.

Hyla versicolor versicolor Le Conte, Common Tree Frog.—The most common tree frog found in most of the county. Specimens were examined from several localities including 5 miles southwest and 10 miles east southeast of College Station. The calls were not heard until April, although specimens were taken as early as March 18. It has been noted that these calls differ markedly from those of *H. v. sandersi* in the vicinity of San Marcos, Hays County; the latter has a lower, more rapidly trilled call.

Rana catebeiana Shaw, Bullfrog.—Occurs commonly throughout the county, often attaining rather large size.

Rana clamitans Latreille, Green Frog.—A series of ten specimens examined were, with the exception of one, taken in the eastern half of the county, apparently inhabiting the larger bodies of water of the Navasota and Lower Brazos River drainages. One specimen, however, was taken 13 miles northwest of College Station. I obtained one specimen from 8 miles east of College Station.

Rana pipiens Schreber, Leopard Frog.—Most abundant of the ranas, it has been recorded widespread in the county.

Microhyla carolinensis (Holbrook), Narrow-mouthed Toad.—Only two specimens have been taken, these from the eastern part of the county, 10 miles east southeast and 14 miles east southeast of College Station on March 13 and May 18, 1946, by B. C. Brown. Both *M. carolinensis* and *M. olivacea* were taken from these exact localities. Since the specimens of each of these forms appear quite typical, the geographical relationships of these forms discussed by Hecht and Matalas (1946) seem open to debate.

Microhyla olivacea (Hallowell), Texas Narrow-mouthed Toad.—Specimens were examined from several localities in the county including those from 10 and 14 miles east southeast of College Station taken by B. C. Brown on March 13 and May 18, 1946. I have also taken specimens in College Station. Calls were first heard in early May.

REPTILES

Alligator mississipiensis (Daudin), Common Alligator.—The single small specimen examined was taken along the Navasota River in June, 1921, by P. F. English, and is now in the Biology Department Collection of the Agricultural and Mechanical College of Texas.

Anolis carolinensis Voight, Carolina Anole.—Nine specimens were examined from various localities in the county. I collected one specimen from College Station in May, 1941.

Sceloporus olivaceus Smith, Texas Spiny Lizard.—A single specimen taken 3 miles

north northwest of Navasota, May 25, 1941, by J. L. Robertson, is the only record for the county. Brazos County appears to be near the eastern limit of its range.

Sceloporus undulatus hyacinthinus (Green), Northern Fence Lizard.—Occurs commonly throughout the county. I have taken three specimens 1 mile north of College Station.

Phrynosoma cornutum (Harlan), Texas Horned Lizard.—A common lizard recorded from widespread localities in the county. I collected over a dozen specimens in my yard at College Station during April and May, 1946.

Cnemidophorus sexlineatus (Linnaeus), Six-lined Racerunner.—A rather common lizard found over most of the county. I have taken a specimen 3 miles south of Wellborn.

Leiolopisma laterale (Say), Brown Skink.—The most abundant of the lizards occurring throughout the county. I have taken several specimens from 1 mile north and 10 miles east southeast of College Station.

Eumeces fasciatus (Linnaeus), Common Five Lined Skink.—Only three specimens were examined from the following localities: 8 miles southeast of Kurten, College Station and 10 miles miles southeast of College Station. I also secured one specimen from Leon County.

Eumeces septentrionalis obtusirostris (Bocourt), Southern Prairie Skink.—Five specimens were examined from various localities near College Station. I secured one specimen from Mr. H. B. Parks who found it at College Station on a thorn of a mesquite tree where it had apparently been pinned by a shrike (*Lanius ludovicianus*). I also collected one specimen 1 mile north of College Station.

Ophisaurus ventralis (Linnaeus), Glass-snake Lizard.—Apparently this form is rather uncommon in the county. The only records available are of two specimens, supposedly from this county, in the collection of the Biology Department. Proper data are lacking for them.

Farancia abacura reinwardtii Schlegel, Mud Snake.—A single specimen was collected in 1940 at the Country Club Lake near Bryan. Additional specimens, however, have been examined from adjacent Leon and Burleson counties.

Heterodon contortrix contortrix (Linnaeus), Spreading Adder.—Four specimens from the county were examined; three from College Station and one from Pitts Bridge 10 miles west of Bryan. A specimen taken at College Station by M. Throckmorton has been kept alive for observation.

Heterodon nasicus nasicus Baird and Girard, Western Hog-nosed Snake.—Two specimens collected at College Station, May 19, 1927, by P. F. English furnish the only authentic records of this form in the county. Additional specimens are in the Biology Department Collection but lack locality data. Of the two collected by P. F. English one is a young male specimen measuring about 12.5 inches in total length, and with ventrals completely black from about the 9th ventral posterior to the end of the tail, while the larger specimen exhibits a series of black blotches on the belly. The coloration on the back of the larger specimen appears typical; however, on the smaller the middorsal spots of the back are very restricted and small, involving 1 and 2 half scale rows; are placed at irregular intervals and appear as a rather continuous middorsal line from the middle of the body to the anus where it terminates. The lateral spots are reduced in size and displaced toward the middorsal line leaving a broad area on each side of unmarked ground color extending upward to the 6th scale row.

Opheodrys aestivus (Linnaeus), Rough Green Snake.—Five specimens were examined from various localities in the county. I secured one specimen from 15 miles southeast of College Station on October 1, 1942.

Coluber constrictor flaviventris Say, Blue Racer.—Four specimens were examined. I collected one specimen at College Station on June 1, 1941.

Masticophis flagellum flagellum (Shaw), Eastern Coach Whip.—This snake appears

to be quite common throughout the county. I collected one specimen in May, 1941, at College Station. Several other specimens from various localities have been examined.

Elaphe laeta laeta (Baird and Girard), Emory's Rat Snake.—Only one specimen, collected by P. F. English, June, 1922, at College Station, is available from the county. Apparently this snake is rather uncommon in this area.

Elaphe obsoleta confinis (Baird and Girard), Chicken Snake.—One of the most common upland snakes, this species has been taken from many localities. I obtained one specimen from College Station. A specimen brought in to Dr. Hobart M. Smith had swallowed a glass egg. These false eggs are sometimes used by local farmers to maintain turkey nests. Although the egg protruded very markedly in its body, this snake consistently ate and was apparently able to carry on digestion in spite of this large indigestible object in its intestinal tract. After being in captivity for several days it was finally able to regurgitate the false egg.

A few juvenile specimens examined exhibited markings on the head similar to those of *E. l. laeta*. In others of the same size the markings were very irregular, and usually much less distinct in slightly larger specimens.

Lampropeltis getulus holbrooki Stejneger, Speckled King Snake.—A series of specimens from this county indicates this form is rather common, at least in the Bryan and College Station areas.

Lampropeltis triangulum amaura Cope, Cope's Milk Snake.—A single specimen given to me by Homer Buck was collected in June, 1941, at College Station. No other records are available for the county.

Natrix erythrogaster transversa (Hallowell), Yellow-bellied Water Snake.—Several specimens have been taken in various localities throughout the county, including 6 miles southwest of Millican, 6 miles west of Bryan and 2 miles southwest of College Station.

Natrix rhombifera rhombifera (Hallowell), Diamond-backed Water Snake.—Probably the most common of all the snakes in this locality; many specimens have been taken in all parts of the county. I have collected them at 2 miles south, 3 miles west, and 8 miles east of College Station.

Natrix sipedon confluens Blanchard, Mississippi River Water Snake.—A series of these snakes have been taken in scattered localities in the county. I collected one specimen 8 miles east of College Station.

Storeria dekayi texana Trapido, Texas Dekay's Snake.—A rather common snake, it has been collected from various points over the county including one taken by me at College Station.

Haldea striatula (Linnaeus), Southern Ground Snake.—A very common species in all parts of Brazos County. I collected 8 specimens from my garden from March 23 to April 6, 1946.

Thamnophis marcianus (Baird and Girard), Marcy's Garter Snake.—Two specimens collected at College Station in 1936 by T. F. Smith are the only records available at present.

Thamnophis sauritus proximus (Say), Western Ribbon Snake.—Rather abundant in many localities. I collected one specimen 15 miles southeast of College Station, October 1, 1941. Several specimens are available in the Texas Cooperative Wildlife Collection and the Biology Department Collection.

Micrurus fulvius tenere (Baird and Girard, Texas Coral Snake.—The four specimens examined are from the same general locality as one taken at College Station, March 14, 1942, by C. J. Hesse.

Agkistrodon mokeson austrinus Gloyd and Conant, Southern Copperhead.—I found

these snakes very abundant 10 miles southeast of College Station. A specimen taken 7 miles west of College Station by F. W. Fitch (Field No. 24) shows apparent intergradation with *A. m. laticinctus;* this specimen might instead be referred to *A. m. mokeson* since the bands across the back are less constricted than in *A. m. austrinus* but not as broad as in *A. m. laticinctus*. The widths of constriction of the bands on the back vary from 3 to 5 scale rows wide and average 3.6. Gloyd and Conant (1943) state that "the range of *austrinus* approaches that of *A. m. laticinctus* in eastern Texas but no indication of intergradation with this form is evident." They (*op. cit.*) list no specimens of *A. m. mokeson* from Texas but show specimens intergrading between *A. m. mokeson* and *A. m. laticinctus* from the general areas of Waco, Dallas, and Sherman, Texas.

Agkistrodon piscivorus leucostoma (Troost), Western Cottonmouth.—Only two specimens taken from this county are available; one collected near College Station in 1935 by S. D. Hinton, and the other 5 miles west of College Station, February 21, 1946, by H. K. Buechner.

Sistrurus catenatus tergeminus (Say), Western Massasauga.—A single specimen collected at College Station, October, 1940, by K. Bonham, is the only record available for the county.

Crotalus atrox Baird and Girard, Western Diamond-backed Rattlesnake.—The only county record available is a large specimen brought in to Dr. R. O. Berry, August 21, 1923, which is supposed to have been collected in the county. It is now in the Biology Department Collection.

Crotalus horridus atricaudatus Latreille, Canebrake Rattlesnake.—Two records are available for the county; one specimen collected near College Station in 1919 by a collector known only from the initials A. R. C. and the other a specimen found by excavating the den of a woodrat (*Neotoma floridana attwateri*), five miles southeast of College Station, November, 1940, by Homer Buck and David Schwinn. This specimen was given to B. P. Glass who sent it to the Baylor University Museum in Waco, Texas.

Sternotherus carinatus (Gray), Keeled Musk Turtle.—Four specimens were available for examination. Two were collected at Sulfur Springs on the Navasota River, April 26, 1930, by P. F. English, and two at Wickson Lake, July 2, 1940, by K. Bonham.

Kinosternon subrubrum hippocrepis Gray, Mississippi Mud Turtle.—Six specimens were examined from the following localities: College Station, 3; Bryan, 1; Green Lake, 1; and 2 miles north of College Station, 1.

Chelydra serpentina serpentina (Linnaeus), Common Snapping Turtle.—Occurs in many lakes and sloughs and along many of the more permanent streams of the county. I have taken specimens 1 and 2 miles southwest of College Station.

Terrapene ornata (Agassiz), Ornate Box Turtle.—A species found abundantly through the county. I have taken several specimens at College Station.

Terrapene carolina triunguis (Agassiz), Three-toed Box Turtle.—A large number of these turtles has been collected over the county. I have seen some specimens that have four toes on one hind foot and three on the other, suggesting a possible integradation with *T. c. major*, which supposedly occurs to the south along the coast. Other specimens examined show markings on the carapace similar to *T. ornata*. I collected one specimen, however, that has markings on the plastron as well as the carapace very similar to those of *T. ornata;* head proportions are typical, however. Mr. H. B. Parks, Curator of the Museum of the A. and M. College of Texas, has recently made a study of the box turtles of this area and suggests that *T. ornata* and *T. c. triunguis* may hybridize.

Graptemys pseudogeographica kohnii (Baur), Kohn's False Map Turtle.—I have examined several specimens of this genus from Brazos County that are apparently referable to this subspecies. The carapace color pattern is somewhat similar to *G. p. oculifera* but lacks

the broad transverse band on the horny ventral surface of the lower jaw which Carr and Marchand (1942) state is typical for that form. Specimens were examined from Wickson Lake, and from the Navasota River, 16 miles southeast of College Station.

Pseudemys scripta elegans (Wied), Troost's Turtle.—A large series of specimens indicates that this is the most abundant of the aquatic turtles in this area. I have taken specimens ½ mile north and 10 miles east of College Station.

Deirochelys reticularia (Latreille), Chicken Turtle.—Three specimens here available are the only records in this county; one collected July 11, 1940, at Green Lake; one May, 1941, at College Station by myself and one April 13, 1946, 10 miles east southeast of College Station by B. C. Brown.

Amyda emoryi (Agassiz), Emorys Soft-shelled Turtle.—I have taken two specimens 10 miles east of College Station and one at College Station, and have examined additional specimens from Wickson Lake and the Little Brazos River.

HYPOTHETICAL LIST

A rather long list could be made of additional species that possibly occur in Brazos County according to supposed ranges, as presently defined; however, the following additions are based on actual records of occurrence in the adjacent surrounding counties. There is little doubt that many of these species will eventually be recorded in this county as well as several not presently known to occur near here.

Manculus quadridigitatus (Holbrook), Dwarf Four Toed Salamander.—Several specimens were taken in Normangee State Park located about 6 miles northwest of Normangee in Leon County, Texas, by several members of our collecting party on March 2, 1946. It is also known west and south of Brazos County, therefore, may be expected to occur there also.

Hyla crucifer crucifer Wied, Pickerings Tree Frog.—One specimen was taken at the above locality on the same date by B. P. Glass and additional specimens from the same locality on March 16, 1946, by B. C. Brown. It may well extend as far west as Brazos County.

Rana palustris Le Conte, Pickerel-frog, LeConte's Leopard Frog.—A total of 13 specimens were taken in Normangee State Park in Leon County; one by myself and the remainder by B. C. Brown.

Crotaphytus collaris collaris Say, Eastern Collard Lizard.—A record of this species is given for Burleson County, Texas, by Burt (1928).

Eumeces laticeps (Schneider), Greater Five-lined Skink.—Reported from Washington County by Taylor (1935).

Cnemidophorus gularis gularis Baird and Girard, Eastern Spotted Race Runner.—Burt (1931) records this species from Washington County.

Leptotyphlops dulcis dulcis (Baird and Girard). Texas Blind Snake.—A single specimen was recovered from the stomach of a striped skunk (*Mephitis mephitis mesomelas*) taken near Hearne, Robertson County, Texas, on June 12, 1941. Data are recorded in the Department of Fish and Game stomachs analysis catalogue (S-3), A. and M. College of Texas.

Lampropeltis calligaster (Harlan), Yellow-bellied King Snakes.—A single specimen examined was collected near Brenham, Washington County, April, 1941, by Mr. A. J. Kirn.

Natrix erythrogaster erythrogaster (Forster), Red-bellied Water Snake.—A specimen

taken in Normangee State Park in Leon County on April 6, 1946, seems referable to this subspecies.

Natrix rigida (Say), Striped Water Snakes.—A specimen also taken from the above locality in Leon County by B. C. Brown appears to be this species.

Tantilla gracilis Baird and Girard, Slender Tantilla.—A specimen is recorded from 3 miles northwest of Hearne, Robertson County, Texas, by Burt (1936).

Sistrurus miliarus streckeri Gloyd, Western Ground Rattlesnake.—One specimen examined from 4½ miles east of Hearne, Robertson County, and two from Normangee State Park in Leon County.

Kinosternon flavescens flavescens (Agassiz), Yellow Mud Turtle.—A series of six specimens collected in Milan County in May, 1946, is the nearest record of this species to Brazos County at present. This area appears to be near the eastern limit of its range.

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The Herpetology of Hardy County, West Virginia

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Observations and collections of the reptiles and amphibians occurring in Hardy County, West Virginia, have been carried on for a period of nine years, from March 1938 until March 1947. The total collection assembled during this period consists of 1,916 specimens representing 49 species and subspecies. *Eumeces laticeps* and *Clemmys guttata* have been recorded from Jefferson County and should be sought for in this region. *Acris crepitans* is known from Hampshire County. *Natrix septemvitta* has been collected in Rockingham County, and *Pituophis melanoleucus melanolecus* from nearby Shenandoah County, Virginia. *Desmognathus ochrophaeus ochrophaeus* and *Pseudacris brachyphona* are possibilities.

Description of Area

Hardy County is situated in the northeastern part of West Virginia. Its area is included between the parallels of 38°46′ and 39°14′ North Latitude, and the meridians of 78°30′ and 78°08′ West Longitude. Its greatest width from east to west is 31 miles, and from north to south, 34 miles; in all, 575 square miles. Physiographically the area lies within the "Valley and Ridge Province" as described by Fennemann. Elevations above sea level vary from 725 feet on the South Branch of the Potomac River to 3,320 feet on South Branch mountain, 4½ miles northeast of Helmick Rocks. The entire area is drained by the tributaries of the Potomac River. The South Branch of the Potomac and its largest tributary, the South Fork, drain the western side of the county. The eastern side is drained by the Cacapon and Lost River and its tributaries.

Climate

Hardy County lies within an area of decidedly reduced precipitation. The mean annual rainfall for Moorefield is 32.05 inches; for Wardensville, 32.07 inches. Because of the ruggedness of the area, there is a wide variation in temperature. The mean temperature at Moorefield is 53.5° F. The maximum and minimum temperatures recorded in the county were 112° F. and —27° F., both at Moorefield. The summers are dry and hot. Snow seldom lies on the ground for more than a total of 40 days. The surface of the ground remains frozen for most of the winter.

LIFE ZONES

The authors conclude that Hardy County lies within the bounds of the Upper Austral and Transition Life ones as delineated by Merriam (1898). The original forests were pre-eminently of oak and pine. Recent lumbering operations have left only remnants of the original virgin timber tracts and the forests, which are now confined to the ridges, consist of second and third growth stands. The mountainous areas, which are considered as falling within the limits of the Transition, are covered with a host of species of *Quercus, Acer,* and *Carya,* with scattered stands of *Pinus virginiana, P. echinata, P. rigida,* and occasional *Tsuga canadensis.*

The only comparatively level land is that along the principal streams. Agriculture is largely confined to the valleys, except along the western border of the county where considerable clearing has been in progress on the highlands for orchards and grazing purposes. The local Agriculture Office estimates that approximately 28 per cent of the total area of the county is used for pasture, meadow, and cultivation. The river valleys are considered as Upper Austral in nature, and within their confines are found such well known species of woody plants as *Juniperus virginiana, Salix nigra, Populus deltoides, Juglans nigra, Diospyros virginiana, Quercus imbricaria, Ulmus americana, Liriodendron tulipifera, Nyssa sylvatica, Platanus occidentalis, Acer saccharinum, Asimina triloba, Fraxinus americana,* and *Robinia pseudoacacia.*

In addition to the above ridge and valley associations, there occurs a third situation which warrants considerable attention. Many square miles of the county are covered with narrow strips of shale-banks to which has been applied the name of shale-barrens. They are typically occupied by a sparse, scrubby growth of *Pinus virginiana, Pinus pungens, Quercus ilicifolia, Quercus stellata, Quercus montans,* and *Kalmia latifolia,* and an admixture of herbaceous species, among which are *Opuntia compressa, Silene pennsylvanica, Viola pedata, Trifolium virginicum, Oenothera argillicola, Pseudoanenidia montana,* and *Convolvulus Purshianus.* Along the ridges these barrens merge into normal woodlands wherever conditions permit the accumulation of soil, and in the valleys they are reduced to various types of clay soils.

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The authors wish to express their appreciation to Dr. Harry Jopson, Professor M. Graham Netting, and Mr. Eugene W. Surber, for reading and criticizing the manuscript. Dr. Nellie Ammons read and suggested certain alterations in the introduction, especially in the part on the lie zones. Professors N. Bayard and Netting were very cooperative in obtaining for us the numbers of specimens deposited in the West Virginia Survey Collection and the Carnegie Museum, and Mr. Netting also provided the scale counts of the *Haldea* and *Storeria dekayi.*

It is impossible for us to list the many people who brought specimens, but each deserves our sincerest thanks, for without their interest many of our rarer specimens might not have been obtained.

The number following the common name of the species indicates the actual number of specimens in our collection or known to exist in other collections. Specimens quoted in the paper are from the following collections: Carnegie Museum (CM), West Virginia Biological Survey Collection (WBS), and L. Wayne Wilson (LWW).

LIST OF SPECIES

1. *Triturus viridescens viridescens* Rafinesque, Eastern Red-spotted Newt (186).—Specimens of this salamander have been obtained from ponds, to an altitude of 1,900 feet, and from the quiet backwaters of the rivers in all parts of the county. Two larvae, with gills, 34 mm. and 36 mm. were taken from a pond on August 31, 1946.

2. *Ambystoma maculatum* (Shaw), Spotted Salamander (31).—The earliest breeding record for this species in the South Branch Valley was March 10, 1945. Specimens of this salamander have been obtained from the floodplains and ridges throughout the county to an altitude of 2,000 feet.

3. *Ambystoma opacum* (Gravenhorst), Marbled Salamander (20).—This salamander has been found most often during the late summer and early fall months under logs and stones close to ponds. A 61 mm. juvenile that still retained vestiges of its gills was collected under a log near a pond 5 miles south of Moorefield, June 8, 1940.

4. *Ambystoma jeffersonianum* (Green), Jefferson's Salamander (32).—Five males were obtained from a small pond 3 miles northeast of Moorefield on the night of February 28, 1946. This pond was revisited on March 3, 1946, at which time 3 males and 3 females were collected. Oviposition had not occurred at the time of the collection. The smallest breeding male taken at this time measured 110 mm. Subsequent collecting on the same evening near Rig added 6 more males and 3 females. A series of 70 larvae collected in scattered pools of a drying pond bed, July 20, 1946, are unusually light in color. In life, the background was a light gray on the dorsal surfaces with a light pigmentation of black, becoming noticeably heavier on the outer edges of the tail fin; the sides of the head were lightly tinged with yellow. The average total length of 50 specimens is 43 mm. The latest date of collection for an adult was October 20, 1946.

A male and female of this species were collected on February 2, 1947, in a small pond on Scott's Ridge, at 1,600 feet elevation, 3½ miles southwest of Rig. A complement of 35 eggs in the yolk plug stage of development was taken at the same time. This is our earliest breeding record for this species.

5. *Desmognathus fuscus fuscus* (Rafinesque), Northern Dusky Salamander (152).—The dusky salamander is found throughout the county in the vicinity of mountain streams, springs, and their seepages. On August 1, 1943, a female with a complement of 35 eggs (LWW 386) in an early stage of development, was found under a log in a drying stream bed. On October 27, 1946, two females containing 44 and 48 ovarian eggs were collected 1 mile east of Flats.

6. *Desmognathus monticola* (Matthes), Seal Salamander (4).—Larvae of the seal salamander have been collected under moss at the foot of Brake Falls during April and May. One adult male was secured at Rock Oak.

7. *Plethodon cinereus cinereus* (Green), Eastern Red-backed Salamander (50).—The red-backed salamander is found beneath logs and stones, and other debris in the forest, or in old fields adjoining valley woodlots. In our series the red-backed phase predominates. At one locality on March 17, 1945, two miles south of Moorefield, two *P. cinereus* were collected at an altitude of 1,000 feet in a field, and at a higher elevation, about 1,600 feet, two *P. richmondi* were found in the forest. Both of the *cinereus* were females and contained 5 and 8 ovarian eggs. The measurements of the two *cinereus* are as follows:

LWW No.	Sex	Costal Grooves	Head-body Length	Tail Length	Tail as Percent of Head Body
506	Female	19	44 mm.	41 mm.	93.1
507	Female	19	41 mm.	42 mm.	102.4

8. *Plethodon richmondi* Netting and Mittleman, Ravine Salamander (5).—All the

specimens in our series have been collected in the woods on ravine slopes. Of the two specimens of *P. richmondi* referred to under the preceding species, one was a female which contained 6 ovarian eggs. Measurements of the two specimens are as follows:

LWW No.	Sex	Costal Grooves	Head-body Length	Tail Length	Tail as Percent of Head Body
504	Female	20	49 mm.	54 mm.	110.2
505	Male	20	45 mm.	53 mm.	117.7

9. *Plethodon glutinosus glutinosus* (Green), Eastern Slimy Salamander (6).—The slimy salamander is found mainly in the heavily wooded mountain sections where it is found under logs and rocks. Sometimes after rains it can be observed moving over the terrain.

10. *Hemidactylium scutatum* (Schlegel), Four-toed Salamander (6).—Three females containing eggs were found in a rotting log, 3 imles southwest of Rig, on April 18, 1946. A female collected at Rock Oak, March 1, 1939, contained eggs. The other two adults were collected in marshy ground under debris at an abandoned sawmill site.

11. *Gyrinophilus porphyriticus porphyriticus* (Green), Northeastern Purple Salamander (26).—The purple salamander is found throughout the county in cool streams and springs. The largest gill-bearing larva measures 142 mm. and was collected at Bass on March 7, 1946. Two additional larvae collected at Needmore on October 20, 1946, measure 48 and 55 mm. Females with large ovarian eggs have been taken in April. The lowest altitude at which this species has been collected is 1,000 feet, at Bass.

12. *Pseudotriton ruber ruber* (Sonnini), Northern Red Salamander (75).—Adults and larvae of the red salamander have been obtained from the valley springs and their seepages, as well as from cool mountain streams, and springs, to an elevation of 2,500 feet.

13. *Eurycea bislineata bislineata* (Green), Northern Two-lined Salamander (50).—This species prefers mountain streams and the seepages of springs. Larvae measuring 60 mm. have been taken in October.

14. *Eurycea longicauda longicauda* (Green), Long-tailed Salamander (42).—The long-talied salamander is found in mountain brooks and springs. Old spring houses, and small, underground, sprisg-fed reservoirs, are favorite hiding places.

15. *Scaphiopus holbrooki holbrooki* (Harlan), Eastern Spadefoot (1).—A single specimen (CM 20975) was collected by Ralph Edeburn in July 1941, at the 4-H Club Camp near Wardensville. This appears to be the only record for the county.

16. *Bufo terrestris americanus* (Holbrook), American Toad (27).—The two species of toads have been found in the South Branch Valley occurring together. Breeding specimens of this toad have been found as early as April 5, and as late as May 28th.

17. *Bufo woodhousii fowleri* (Hinckley), Fowler's Toad (50).—Fowler's toad appears to breed two to three weeks later than the American toad. Breeding specimens have been found as early as April 25, 1943. There appears to be little difference between the species in their choice of breeding sites. This species has been found breeding in the quiet waters of permanent ponds and roadside ditches; both upland and lowland.

18. *Pseudacris nigrita feriarum* (Baird), Eastern Chorus Frog (136).—Our specimens of *Pseudacris* have been identified by Dr. Charles Walker. The earliest record of their appearance is February 19. A pair of *Pseudacris* brought into the laboratory on April 7, 1941, mated and deposited 175 eggs in 3 masses on April 8th. Tadpoles about 5 mm. long hatched on April 15th. The latest date at which this species has been collected is October 22nd.

19. *Hyla crucifer crucifer* (Wied), Spring Peeper (125).—Specimens of the spring peeper have been obtained from all parts of the county. The earliest record of its appearance was February 19, and the latest October 20.

20. *Hyla versicolor versicolor* (Le Conte), Gray Tree Frog (9).—Although few specimens of this evasive frog have been collected, it has been heard in all parts of the county. The extreme dates that it has been heard calling are April 10 and September 30.

21. *Rana catesbeiana* (Shaw), Bullfrog (20).—Pre-season hunting has reduced the bullfrog population to a dangerously low percentage of its former abundance. Transformed individuals have been collected in June and early July. Occasional large males may be found along the edges of ponds and backwaters.

22. *Rana clamitans* (Latreille), Green Frog (100).—With the decline of the bullfrog, hunters have turned their attention to the green frog, which is still plentiful in our streams and ponds.

23. *Rana palustris* (Le Conte), Pickerel Frog (100).—The pickerel frog frequents the margins of meadows, brooks, ponds, springs, and woodland streams. It has been collected in all parts of the county.

24. *Rana sylvatica sylvatica* (Le Conte), Southern Wood Frog (43).—The wood frog breeds in ponds and transient pools throughout the county. Dates for freshly laid egg massse vary from March 12 to April 22. On March 18, 1946, eggs were found in a small transient pool, 5 imles southeast of Moorefield. Upon returning to the same place on July 14, transforming individuals were collected. The tadpoles of this species have been observed to feed upon *Ambystoma maculatum* eggs. Extreme dates on the observation of the wood frog are February 26 to October 19.

25. *Sceloporus undulatus hyacinthinus* (Green), Northern Fence Lizard (82).—The fence lizard is locally known as the "scorpion." Specimens have been obtained from all parts of the county.

26. *Leiolopisma laterale* (Say), Ground Skink (5).—The ground skink was first recorded from West Virginia by Wilson (1941, p. 268) on the basis of two specimens from Hardy County. Since that time 3 additional specimens have been collected in the county. The largest individual, a female, collected at Brake, March 28, 1945, has a snout to vent length of 50 mm.; it contained 4 ovarian eggs averaging 4 mm. in diameter. The first specimen (CM 20098) oclected was under a large limestone rock in a pasture field, the second was found in a chrysanthemum bed. The other three specimens were all found in the forest among leaves.

27. *Eumeces fasciatus* (Linnaeus), Blue-tailed Skink (37).—Specimens of the blue-tailed skink have been obtained from all parts of the county, the wooded areas as well as from all the valleys. While this species requires moist environment, we have a few records from dry sandy soil, and one individual from the shale-barrens. The largest specimen, a male, measures 196 mm. in total length. One animal of the series has a single postmental.

28. *Eumeces anthracinus* (Baird), Coal Skink (1).—A female of this species was collected at Bass on April 12, 1947. The animal was found on the slope of a ravine under a heavy covering of fallen oak leaves overlying small stones. It is interesting to note that the other species of lizards and skinks listed for the county have also been collected in this particular situation.

29. *Carphophis amoena amoena* (Say), Eastern Worm Snake (25).—The eastern worm snake is found in the upland forests to 3000 feet and valley woodlots under fallen logs and stones.

30. *Diadophis punctatus edwardsii* (Merrem), Northern Ring-necked Snake (23).—Specimens of this snake are available from all parts of the county where there is a suitable habitat of good forest cover and moist soil.

31. *Heterodon contortrix contortrix* (Linnaeus), Northern Spreadhead (18).—The spreadhead has been found in the mountains and valleys throughout the county. Two melanistic individuals were collected in the spring of 1946.

32. *Opheodrys vernalis vernalis* (Harlan), Eastern Grass Snake (6).—The smooth green snake is an inhabitant of the mountains and upland meadows. A single specimen was collected in the valley at Moorefield at about 840 feet elevation. They are easily maintained in captivity, taking as food, small ground beetles, crickets, wood roaches, grasshoppers, centipedes, millipedes, and small spiders.

33. *Coluber constrictor constrictor* (Linnaeus), Black Racer (26).—A female of this species (CM 13747) collected near Moorefield, May 30, 1938, by L. Llewellyn, contained 15 eggs. It is found throughout the county at all elevations.

34. *Elaphe obsoleta obsoleta* (Say), Pilot Blacksnake (23).—The pilot blacksnake is being recognized as a beneficial species and is afforded some protection by local farmers. A female killed at Moorefield, May 20, 1942, contained 8 eggs. The largest recorded specimen, a male, measured 73 inches.

35. *Lampropeltis getulus getulus* (Linnaeus), Northern King Snake (12).—The king snake was first recorded from West Virginia by Netting (1936) on the basis of one preserved specimen from Grant County and reports of two others from Grant and Pendleton Counties. Since that time Wilson and Friddle (1946) have reported on a series of twelve specimens and eleven observation records, mostly from Hardy County.

With a few exceptions, West Virginia specimens agree well with published descriptions. All of our series are shiny black with deep yellow cross bands. In a series of eleven specimens the ventrals average 216, and the croso bands 38.

It appears that the king snake inhabits the valleys, generally close to water, although indications are that it might possibly be found in upland pastures and meadows to an elevation of 2,000 feet. While it has been collected on the highway, it has most often been found in the fields during hay or wheat harvest and only occasionally in the forest.

36. *Lampropeltis triangulum triangulum* (Lacépède), Upland House Snake (14).—This snake has been obtained from all parts of the county. It is not limited by altitude in this county.

37. *Natrix sipedon sipedon* (Linnaeus), Northern Banded Water Snake (116).—The northern banded water snake inhabits the margins of the mountain and valley streams. A female collected on Keller's Island, near Fisher, on May 17, 1944, contained 20 well developed embryos. On August 24, 1942, a female containing 21 young, which averaged 220 mm. in total length, was collected near Moorefield.

38. *Storeria dekayi dekayi* (Holbrook), Dekay's Brown Snake (5).—Five specimens of this secretive snake have been found in Hardy County; two on the highway, and the others under piles of trash. Number 268 has the second to the fifth caudal plates entire. One specimen (LWW 241) has an abnormal head and has been turned over to Carnegie Museum for further study. Data on these specimens are presented in the table below:

LWW Number	Sex	Scale Rows	Ventrals	Caudals	Total Length	Tail Length
242	Female	17	136	44 mm.	295 mm.	57 mm.
309	Female	17	116	44 mm.	331 mm.	66 mm.
107	Male	17	127	54 mm.	270 mm.	70 mm.
268	Male	17	120	51 mm.	251 mm.	61 mm.
241	Juvenile	17	127	36 mm.	124 mm.	22 mm.
241	Juvenile	17	127	44 mm.	172 mm.	34 mm.

39. *Storeria occipitomaculata occipitomaculata* (Storer), Northern Red-bellied Snake (30).—Records of this species are rather generally distributed over the county.

40. *Haldea valeriae valeriae* (Baird and Girard), Eastern Ground Snake (5).—This species is one of West Virginia's rarest snakes. It is represented in our collection by five specimens from Hardy County and one from Grant. We find that this snake prefers the moist limestone soil of our forests; only one specimen was collected in the valley. In our series its vertical range is from 850 feet to 2,900 feet. A female, (WBS 1313) collected August 10, 1941, was pregnant. Data on these specimens are presented in the table below:

LWW Number	Sex	Scale Rows	Ventrals	Caudals	Total Length	Tail Length
21	Female	15	116	34	183 mm.	35 mm.
WBS 1313	Female	15	124	22	234 mm.	35 mm.
212	Female	15	126	28	230 mm.	31 mm.
220	Male	15	121	36	190 mm.	34 mm.
252	Male	15	122	24	260 mm.	28 mm.
201*	Juvenile	17	121	28	125 mm.	18 mm.

* Grant County.

41. *Thamnophis sauritus sauritus* (Linnaeus), Eastern Ribbon Snake (8).—The ribbon snake is partial to the swampy meadows and pasturelands of the valleys. Of our series of 8 specimens, all are females; the largest one measures 750 mm. in total length. This particular specimen was captured on a warm day in January 1946. She was heavily covered with mud and quite active. Four of the females were gravid; the following table lists the size of the eggs, number, and date:

LWW Number	Date of Capture	Size of Eggs	Number of Eggs
230	May 14, 1945	13 x 7 mm.	11
289	May 13, 1946	8 x 7 mm.	14
288	May 13, 1946	10 x 5 mm.	16
287	May 13, 1946	10 x 8 mm.	16

42. *Thamnophis sirtalis sirtalis* (Linnaeus), Eastern Garter Snake (24).—The garter snake has been found on the ridges and in the valleys throughout the county.

43. *Crotalus horridus horridus* (Linnaeus), Timber Rattlesnake (4).—The rattlesnake inhabits the mountains but like the copperhead an occasional specimen finds its way to the valleys.

44. *Sternotherus odoratus* (Latreille), Musk Turtle (20).—This small turtle may be found along the quiet margins of the larger river, backwaters, and small sluggish streams. Only occasionally is it found in ponds. *Sternotherus* is a weak swimmer and like *Chelydra* seeks the quiet backwashes of our rivers when they are in flood stage. This is especially true if the water floods recently plowed fields, for the turtle then burrows into the soft mud and may often be found there after the water has receded. The alga generally found on the carapace has been identified as *Rhizoclonium hieroglyphicum*.

45. *Chelydra serpentina serpentina* (Linnaeus), Northern Snapping Turtle (22).—The snapper is found abundantly in the larger streams of the county.

46. *Clemmys insculpta* (Le Conte), Wood Turtle (6).—All of our specimens of this turtle have been found in damp woodlands or upon a highway adjoining such situations. Two individuals were found to be infected with larvae of the flesh-fly *Sarcophaga cistudinis* Aldrich.

47. *Terrapene carolina carolina* (Linnaeus), Eastern Box Turtle (54).—The box turtle is found in the valleys below 1,000 feet and is seldom observed above 2,000 feet on the ridges.

48. *Chrysemys picta* (Schneider), Eastern Painted Turtle (54).—Seemingly the painted turtle prefers the small ponds and backwaters where there is heavy aquatic growth. It is also found in the deeper and more sluggish holes of water in the rivers, where it may be seen sunning itself on logs and stumps projecting above the surface of the water. Specimens from Hardy County appear to be intergrades between *C. picta picta* and *C. picta marginata*. A more exacting study must be made from a larger series of specimens to establish the status of the Hardy County population.

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Size and Scutellation in Natrix septemvittata (Say) in Southwestern Ohio

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The extensive range of *Natrix septemvittata* in the eastern and central United States indicates the strong possibility of territorial variation in such characteristics as size, proportions, and scutellation. Evidence of territorial differences can only be obtained through the study of suitable specimen samples from limited, defined areas in remote parts of the range. At the time of writing no comparable reports have appeared in the literature with data that can be evaluated and compared with the findings compiled in Figs. 1-5. We hope that this report can be used by other workers investigating the species in other areas.

Southwestern Ohio consists of a block of counties drained in whole or in part by the Great and Little Miami Rivers, and their tributaries. This includes counties from Logan south to the Ohio River, and from Champaign west to the Indiana boundary. This territory is close to the center of the geographic range of *Natrix septemvittata* on the east-west axis, but well north of center on the north-south axis. It is probably much closer to the center of population density than to the center of the range. It is of particular interest because of the remarkable local abundance of queen snakes in suitable habitats.

Data in this report is based upon a study of several series of *Natrix septemvittata* totaling 188 individuals. These have been deposited in almost equal numbers in the following collections: United States National Museum; Dayton Public Museum; and the private collection of the junior author. The majority of the queen snakes came from Brown and Montgomery Counties, represented by 72 and 98 specimens respectively. The remainder were obtained from the following counties: Champaign (1); Greene (5); Logan (3); Miami (5); Preble (3); and Warren (2). No correlation exists between the number of specimens collected in any county and the actual abundance of its *Natrix septemvittata* population. The majority of specimens came from Montgomery because of the accessibility of the habitats, and the long Brown County series is the result of encountering an unusual aggregation prior to hibernation. Field observations indicate the presence of queen snake populations of local abundance in almost every county of southwestern Ohio.

Natrix septemvittata has been collected in nearly every township of Montgomery County, but most of the 98 specimens studied for this report were

obtained from Randolph Township. The habitat that has most uniformly provided a supply of *Natrix septemvittata* in Randolph Township has been a short section of the west bank of the Stillwater River below the spillway of

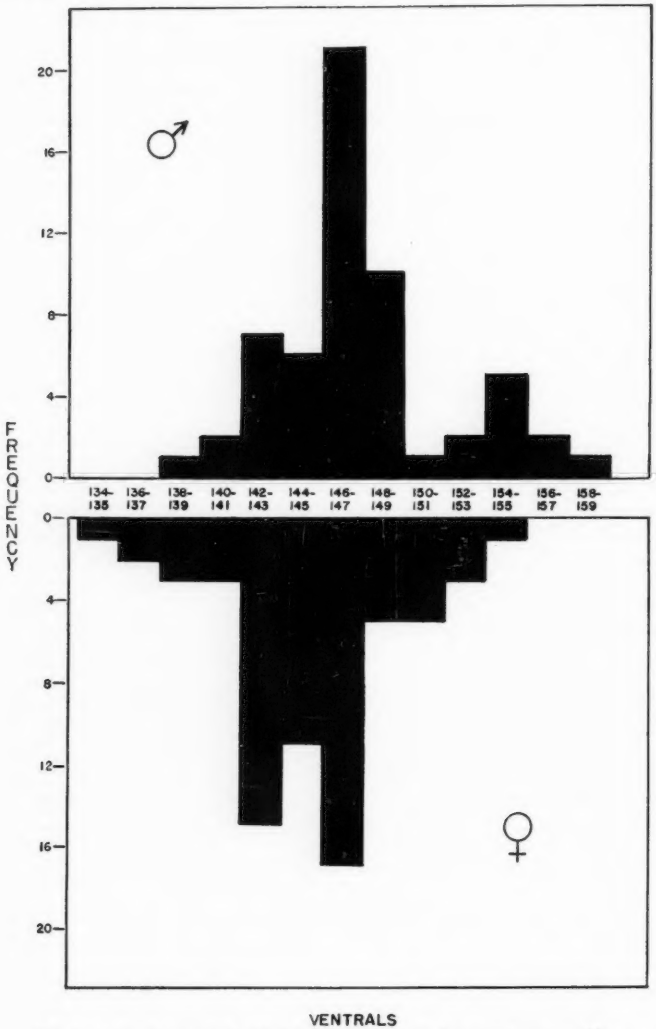

Fig. 1.—Ventral counts of 124 *Natrix septemvittata* from southwestern Ohio (58 males, 66 females).

Englewood Dam, and above Rock Creek. This habitat has an ample supply of sun-warmed water flowing slowly near the shallows off the west bank, a plethora of flat rock slabs both in the water and on the water's edge, and a dense crayfish population.

Largest group of specimens obtained at one time from one place was a series of over 125 *Natrix septemvittata* collected from White Oak Creek near New Hope, Brown County, on September 22, 1946 by the junior author aided by D. E. Ladd and R. C. Riecken. These specimens were collected in less than an hour from a 100 yard section of the creek. Th habitat was a shallow, moderately-flowing rocky creek bordered by abrupt limestone outcroppings on one side, with a lower exposure of rock over a talus slope on the other side. Ledges and loose flat rocks were plentiful. Of these 125 specimens, 71 were available for study in this report.

Scutellation.—Conant (1938: 77) reported on the range in scutellation for male and female *Natrix septemvittata* from Ohio on the basis of a series of 68 specimens, and McCauley (1945: 104) provided similar data for Maryland based on a series of 33 specimens. These reports cover extensive territories with specimen series too short to indicate reliably much more than the probability of regional variations in scutellation.

Ventral scutes were counted in 124 *Natrix septemvittata* from southwestern Ohio, and are presented in Fig. 1. Males (58) ranged from 139 to 158 ventrals (mean 147 plus); females (66) ranged from 135 to 154 (mean 145). These ranges and means approximate Conant's (1938: 77), and are higher

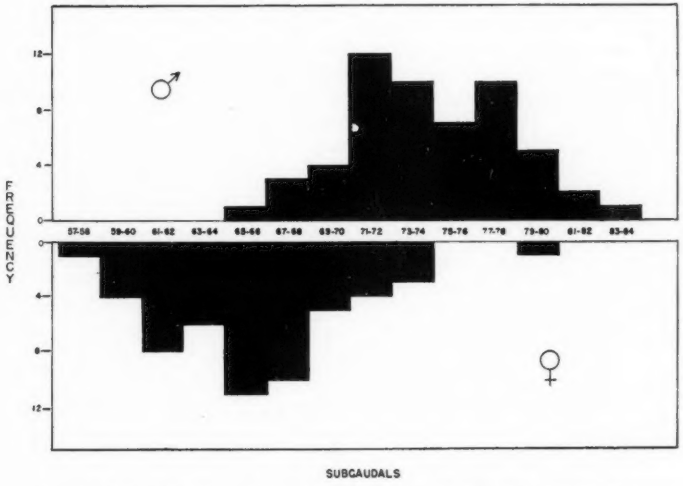

Fig. 2.—Subcaudal counts of 108 *Natrix septemvittata* from southwestern Ohio (55 males, 53 females).

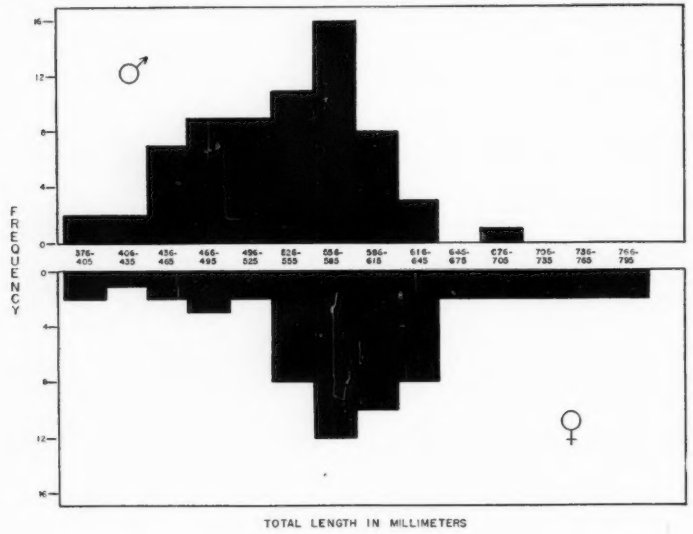

Fig. 3.—Total lengths of 126 *Natrix septemvittata* from southwestern Ohio (68 males, 58 females)

than those reported by McCauley for Maryland (1945: 104). The histogram (Fig. 1) for ventral scute counts demonstrates a marked central tendency for both sexes, whereas the extremes of range are represented by the few aberrant individuals, and the majority of specimens fall within much more limited ranges. The similarity in the ranges of variation in the two sexes, as substantiated by the means, indicates that sexual dimorphism is insignificant in this character.

Subcaudals were counted in 108 specimens (Fig. 2). Males (55) ranged from 65 to 83 (mean 74); females (53) ranged from 58 to 74 (mean 66). In the subcaudal histogram (Fig. 2) the differences in male and female ranges and frequency-distribution indicates a marked, though overlapping sexual dimorphism. Since 2/3 of all specimens have subcaudal counts falling within the range of overlap, the subcaudal count has limited value in sexing specimens.

In 125 specimens the majority (114) had 7 supralabials; the remaining specimens (11) had 8. Infralabials were more variable in number. In 125 counts 60% (75) had 10; the remaining specimens (50) had 9 (27), 11 (22), or 8 (1). In 124 of 125 specimens 2 preoculars were present; remaining specimen had 1. In 121 of 125 specimens 2 postoculars were present; remaining specimens had 3 (4). In 113 specimens 88 had a temporal count of 1-2-3; the remaining specimens (25) had 1-2-2 (13), 1-3-3 (5), 1-1-3 (3), 1-1-2 (2), 2-2-3 (1), and 1-2-4 (1).

Size and Proportions.—Maximum size has been listed for *Natrix septemvittata* for various parts of its range, by Conant (1938: 77), McCauley (1945: 103), Pope (1944: 192), and Triplehorn (1949: 76). In every instance, as well as in Raney and Roecker's (1947: 173) Fig. 1, the longest specimens known are female regardless of the part of the range from which they come.

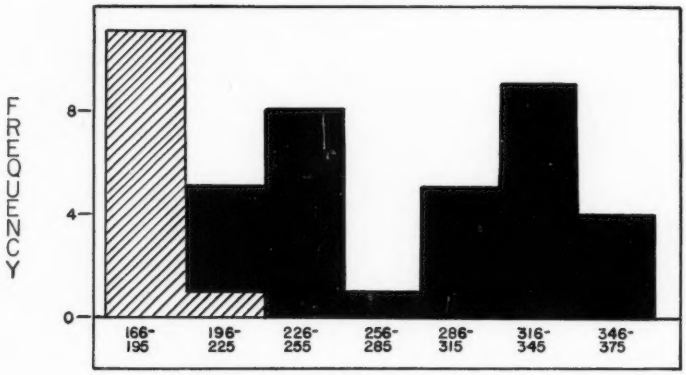

Fig. 4.—Total lengths of 43 juvenile *Natrix septemvittata* from southwestern Ohio.

This is also apparent in southwestern Ohio, as illustrated in Fig. 3. The length frequencies of 126 *Natrix septemvittata* are presented in a histogram, showing that males (68) range from the minimum size for which sex was determined by us, 375 mm., to a maximum of 692 mm. (mean 529 mm.) while females (58) range from the same arbitrary minimum to the greater maximum of 787 mm., (mean 584 mm.).

Specimens having total lengths of less than 375 mm. are illustrated in Fig. 4, and are classed as juveniles. In southwestern Ohio *Natrix septemvittata* produce their broods of young during later July and August. The specimens in Fig. 4 represent two well-defined year-groups, with the first unit, or smaller specimens, the young-of-the-year, and the second massing of individuals includes queen snakes in their second year of life. All specimens from the third year until death are presented in Fig 3, with no other year-groupings evident. The twelve specimens in Fig. 4 represented by the diagonal-lined block are all new-born young of a single brood.

Growth rate, in the second year group and third (plus) grouping (Fig. 3 and 4) indicate a length increment of about 50% in the second year, and a diminishing rate of growth from the third year on. These findings are in accord with those determined in northern Michigan by Blanchard and Finster (1933: 347); and in western New York by Raney and Roecker (1947: 174). Females appear to have a greater annual length increment and attain a greater maximum length.

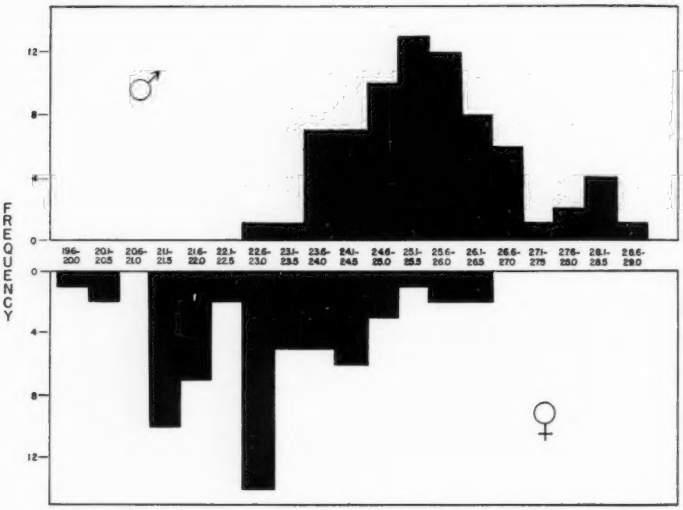

Fig. 5.—Tail length/total length proportions of 133 *Natrix septemvittata* from southwestern Ohio.

Tail lengths, as proportions of total lengths, are illustrated for 133 *Natrix septemvittata* in Fig. 5. Males (73) range from 23.0 to 29.0 per cent, with the major block of specimens ranging from 24.6 to 26.0 per cent. Females (60) range in tail/total proportions from 19.6 to 26.5 per cent, with a tall block of individuals between 22.6 and 23.0 per cent, but a more dispersed spread in total lengths than noted in males. There is evidently a marked, though overlapping sexual dimorphism in tail/total proportions in *Natrix septemvittata*.

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The Occurrence of an Intermedium in Lizards

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When Fürbringer (1870) described the tarsus of a lizard he stated without equivocation that the wrist was made up of nine bones arranged in two rows. Proximad there were the radiale and ulnare between which there was a small centrale and over the end of the ulnare was the pisiform bone. Distad there were the five carpalia arranged to form a second row. Born (1876) seems to have been the first to discover an intermedium in a saurian form. In the wrist of a very young specimen of *Lacerta agilis* he identified a small cartilage in the space between the distal ends of the radius and ulna as a rudimentary intermedium. Later he was able to discern the bone in adult specimens of several other species of lizard. Hoffmann (1890) generally agrees with Born in regard to the occurrence of an intermedium in lizards. But Cope (1892) confuses the issue with his description of the wrist bones of lizards. He says that the constitution of the wrist is very uniform in species possessing well-developed anterior limbs. the proximal row being composed of three distinct elements, radiale, intermedium and ulnare. Cope, however, equates the ulnare with the pisiform describing it as being mainly external to the ulna and directed posteriad. This description fits the pisiform rather than the ulnare. Cope describes the centrale as a small bone distal to the radiale and intermedium, lying between them and the five carpalia of the second row. It seems quite evident from this description that Cope failed to identify the ulnare and pisiform as separate entities and labeled as an intermedium what in reality was an ulnare. Cope actually did not find then an intermedium in any of the lizards he described.

Siebenrock (1895) reported the presence of an intermedium among lizards but stated that in the Scincidae only the species *Eumeces schneideri* possesses this structure. Later, Gegenbaur (1898) made the generalization that the position of the intermedium in the carpus of *Sphenodon* is occupied by the centrale in lizards; in which forms the intermedium is not found at all. Camp (1923) found the intermedium always small and frequently absent in the Sauria. He stated that the intermedium was found only sporadically among somewhat primitive families but entirely absent as far as he knew in the Gekkota. Williston (1925) found that none of the saurian forms which he examined possessed an intermedium though he mentions that he had read reports of its presence in the Lacertidae. Sewertzoff (1931) illustrated the intermedium in the wrist of *Eumeces schneideri.* Barrows and Smith (1947) describe and figure a small intermedium in the wrist of *Xenosaurus grandis.* While El-Toubi (1947) in his paper on the osteology of the lizard, *Agama stellio,* states that in the bones of the hand "the intermedium is distinctly large." He concludes that the retention of a large intermedium in *Agama stellio* recalls the condition in primitive reptiles. After checking El-Toubi's description and illustration (Fig. 8-A) I am convinced that he repeated the error made by

Cope mentioned above i.e., confused the pisiform with the ulnare and the ulnare with the intermedium. Probably this lizard does not have an intermedium but simply a pisiform and an ulnare distal to the ulna. A specimen of *Agama camasica* which I examined did not have an intermedium.

In view of the contradictions apparent in the opinions of the above mentioned workers, it would seem that any new information pertinent to the presence of an intermedium in the Sauria would be valuable. The present report is based on many of the same specimens which furnished material for the study of the girdles (Stokely, 1947). I am grateful to Mr. Arthur Loveridge of the Museum of Comparative Zoology at Harvard University and to Mr. Karl P. Schmidt of the Chicago Natural History Museum for the privilege of the continued use of many specimens loaned from their respective institutions. A number of the specimens observed, including all of those from which the figures* were drawn, are from the collections at the University of Notre Dame. Since these specimens were cleared and stained as previously reported (Stokely, 1947) I believe that it was possible to detect the intermedium where it might have been very easily overlooked by the methods of earlier workers.

The scattered distribution of the intermedium certainly appears puzzling. Born (1876) Hoffmann (1890) and Wiedersheim (1909) report the occurrence of an intermedium in the genus *Lacerta*. The three species of this genus examined by me all possessed the bone (Fig. 6) and it may quite characteristically be present throughout the genus. As already mentioned Sewertzoff (1931) figured the intermedium in the wrist of *Eumeces schneideri* and Siebenrock (1895) stated that this was the only species in the Scincidae which possessed an intermedium. But I have found an intermedium in two other species of *Eumeces* and absent in one additional species (Figs. 3-5).

Born (1876) noted the absence of the intermedium among the Ascalabota. As a generalization this observation was somewhat modified by Camp (1923) who states that the bone is almost universally absent among the Ascalabota. Among the specimens which I examined which were from the division Ascalabota I found no intermedium in the following species: *Coleonyx variegatus* (Gekkonidae); *Agama camasica* (Agamidae); *Polychrus mormorata, Uma notata, Crotaphytus wislizenii* (Iguanidae). In a specimen of *Sceloporus magister*, an x-ray picture shows what I believe to be an intermedium but I cannot identify it with certainty.

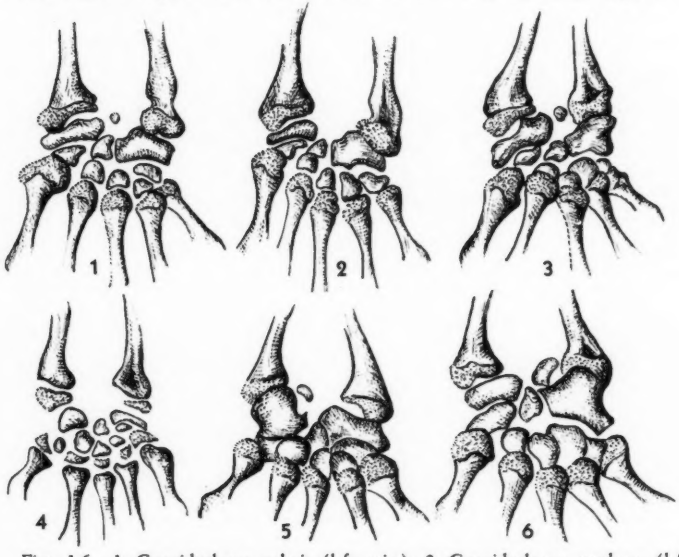
Among the Autarchoglossa I was not able to discern an intermedium in the following forms: *Ameiva ameiva praesignis, Bachia intermedia, Cnemidophorus melanostethus, C. perplexus,*** *Ophiognomon abendrothi* (Teiidae); *Ablepharus boutonii, Brachymeles gracilis, B. schadenbergii, Chalcides sepsoides, C. ocellatus, C. striatus, C. tridactylus, Eumeces skiltonianus* (Scincidae); *Chamaesaura anguina tenuior* (Zonuridae).

* I wish to thank sincerely Mr. Ralph Bruneau, student in the Department of Fine Arts at the University of Notre Dame, who made these figures for me. They were drawn while making observations of the specimens under low power of a binocular microscope. The figures are from about 15 to 20 times natural size.

** *Cnemidophorus perplexus* here mentioned is the form referred to as *C. octolineatus* by Schmidt and Smith (1944).

However, an intermedium was detected in specimens of each of the following species of the division Autarchoglossa: *Cnemidophorus gularis, C. hyperythrus beldingi, C. T. tessellatus* (Teiidae); *Xantusia henshawi* (Xantusiidae); *Lacerta erhardi riveti, L. pityusensis grossae, L. sicula campestris* (Lacertidae). It is to be noted that quite commonly the intermedium is sporadically present not only in a family but also within a given genus of that family. Deserving of special attention is the discovery of the presence of an intermedium in *Cnemidophorus gularis* and its absence in the supposedly closely related species, *C. perplexus* (= *octolineatus*) (Figs. 1, 2).

Evidently the intermedium does tend to disappear in the Sauria. Born (1876), Hoffmann (1890) and Gegenbaur (1898) have almost identical explanations for this phenomenon. All three authors point out that in the Urodela and Chelonia (where the intermedium is universally present) the distal ends of the radius and ulna are quite close together, pushing against the intermedium which is the middle piece in an arch formed by the radiale, intermedium and ulnare. But among the Sauria the radius and ulna tend to diverge distad. Their contact with the intermedium is lost. The bone subsequently is reduced and comes to lie deeper in the spatium interosseum. The closing of the arch of the proximal row of carpals is taken over by the centrale. Camp (1923) contends that the loss of the intermedium seems to occur by its fusion with the neighboring ulnare which sometimes forms a pocket for its reception. I have found no specific evidence for this view and from the isolated position



Figs. 1-6.—1. Cnemidophorus gularis (left wrist); 2. Cnemidophorus perplexus (left wrist); 3. Eumeces multivergatus (left wrist); 4. Eumeces skiltonianus (right wrist); 5 Eumeces anthracinus (right wrist); 6. Lacerta sicula campestris (left wrist).

of the tiny intermedium in *Cnemidophorus gularis* (Fig. 1), one might suppose that the vestige ultimately disappears without fusion with any other wrist components.

None of the species in which Camp (1923) found an intermedium were among the species examined by me. However, I was able to substantiate his findings by confirming the absence of this bone among certain species of the genera *Coleonyx*, *Crotaphytus* and *Bachia*. With regard to the irregular distribution of the intermedium, Camp holds that it is always among genera of primitive families that the bone is found and yet never known in the Gekkonidae and Uroplatidae which, in most respects, are considered primitive. But as already mentioned, I have found the intermedium in the Teiidae which group, according to the Camp's chart (*op. cit.* p. 333), is not a particularly primitive family.

From the work of former investigators and from my own observations, I would conclude that the loss of the intermedium is an evolutionary process quite apart from the general conditions involved in the production of limblessness. This contention seems to be upheld particularly by the frequent occurrence of the intermedium among the Scincidae and Teiidae which so frequently exhibit reduction of the limbs. On the other hand, the element is consistently absent in the Gekkonidae and throughout most of the division Ascalabota which never undergo diminution of the extremities.

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Tursiops gillii, the Bottlenosed Dolphin, a New Record From the Gulf of California, With Remarks on Tursiops nuuanu[1]

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On a recent field trip of the Stanford Natural History Club to Puerto Penasco, Mexico, two specimens of the Bottlenosed Dolphin, *Tursiops gillii* Dall, were found. Both animals were discovered dead on March 22, 1948, about 100 feet above the high tide mark on a beach approximately one-fourth mile north of Punta La Cholla, or Rocky Bluff Point as it is called by some in the area. Punta La Cholla is about six miles north of the town of Puerto Penasco, Sonora, Mexico, near the head of the Gulf of California.

Mr. Jay M. Savage, who found the specimens, reports that the skins were still intact, although the interior of the animals had been eaten away, probably by ants. It was still possible to observe the uniform brownish-gray coloration, and to determine the length of one animal as approximately eight feet, the length of the other as about ten feet. The heads were removed, and the skulls presented to the Natural Museum of Stanford University, where they are recorded in the collection as specimens numbers 4449 and 4450. As far as can be determined, this is the most northerly record for the species in the Gulf of California.

The only other species of *Tursiops* occurring in this area is *Tursiops nuuanu* Andrews. Through the great courtesy of Dr. Remington Kellogg, Director of the U. S. National Museum, and Dr. Henry W. Setzer, Associate Curator, Division of Mammals, U. S. National Museum, significant measurements were obtained of two specimens of *Tursiops nuuanu* which were not included in the original description of Andrews. Also provided were measurements of one specimen of *Tursiops gillii* which have never been published. These measurements, together with those of the two specimens from Mexico, are given below. (p. 184)

In the original description of *nuuanu*, Roy Chapman Andrews cites the small size of the temporal fossae of this form as evidence of its specific distinctness from *gillii* (p. 234). Dr. Setzer's observations on these two specimens give additional information for this identification. His observations are recorded as follows:

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1 Results of the Stanford Natural History Club Expeditions to the Gulf of California No. 3.

Measurements in millimeters of:	*Tursiops gillii*						*Tursiops nuuanu*			
	6 mi. N. Puerto Penasco—Mexico Stanford NHM No.				Lower Calif. old adult USNM Number		70 mi. S. Panama Pacific Ocean Aug. 15-29 Young USNM Number		No data USNM Number	
	4449		4450		12054		254910		21049	
Maximum condylobasal length of skull	511		508		538		476		—	
Maximum length of rostrum	336		326		304		268		—	
Width of rostrum at base (antorbital notches)	130		135		139		126		—	
Width of rostrum 60 mm. anterior to antorbital notches	106		103		104.6		94.6		—	
Breadth across preorbital angles of supraorbital processes	222		229		240		222		218	
Breadth across postorbital angles of supraorbital processes	256		253		273		241		248	
Zygomatic breadth	260		257		281		239		244	
Width of braincase across parietals	212		202		185		179		179	
Maximum distance between outside margins of premaxillaries	94		95		99		88		95	
	R	L	R	L	R	L	R	L	R	L
Total number of teeth in upper tooth row	22	22	21	20	19+	22	23	24	22	23
Length of upper tooth row	254	249	240	238	—	247.2	212	213	217	221
Hinder end of upper tooth row to end of premaxillary	251	247	237	235	—	254.7	215	216	227	226
Total number of teeth in lower tooth row	—	—	19	19	22	21	20	20	20	22
Length of lower tooth row	—	—	221	221	248	241	203	203	213	216
Hinder end of lower tooth row to end of mandible	—	—	203	206	257.4	251.6	209	211	218	218
Maximum length of mandible	—	—	424	428	459	462	404	408	410	411
Maximum height of mandible through coronoid	—	—	98	99	99.5	99.5	80.5	80.5	—	—
Length of symphysis	—		65		58		—		—	

"*Tursiops gillii*, No. 12054—Temporal fossa large and directed caudad into a rounded point; occipital condyles large; rostrum rather flat; widest part of skull being across zygomatic arches; temporal bone rather narrow and elongate; dorsal margins of occipital condyles distinct; mandibles large and robust and wider dorso-ventrally at coronoid than *Tursiops nuuanu*.

Tursiops nuuanu, Nos. 254910 and 21049—Temporal fossa relatively small and directed caudo-dorsad into a rounded point; temporal bone wide and rather short; rostrum, when viewed from the side, rather rounded dorsally; widest part of the skull not across zygomatic arches but across postorbital processes of supra-orbital; occipital condyles small in comparison with *Tursiops gillii;* dorsal margins of occipital condyles merge into supra occipital with no truly distinct border even in young; mandibles rather small and not robust, relatively narrow dorsoventrally at coronoid."

In investigating the literature dealing with marine mammals, the author has been struck with the lack of detailed locality records. Scammon's *Marine Mammals* (1874), for example, gives many localities simply as "oceans and bays." While there are comparatively few accurate locality records in the literature, there must be innumerable instances of marine mammals stranded on beaches or trapped in coves of which no mention ever appears in the literature. Occasionally, one sees mention of such occurrences in the newspapers, but seldom are these notes recorded where they would be available to students of marine mammals, providing not only locality records, but seasonal ones as well. For this reason, the above note is published in the hope that others with similar information on marine mammals will endeavor to make it available to the other workers in the field.

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Germination Studies of Wisconsin Prairie Plants*

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The methods and rates of reproduction of the most important prairie species have been studied in some detail in connection with the establishment, on the University of Wisconsin Arboretum at Madison, of large-scale examples of the main plant associations of the prairie-forest border region. To assist with the restoration of the tall grass prairie (*Andropogon-Sorghastrum*) various additional studies have been made concerning the species composition of nearby prairie relics (Curtis and Greene, 1949), and the effect of fire on the behavior of prairie perennials (Curtis and Partch, 1948). The present paper reports briefly on one phase of the reproduction studies, namely the germination behavior of the seeds of 91 species of prairie plants.

The establishment of artificial prairie is feasible only through direct seeding methods, since the cost of transplantation with either nursery stock or with plants collected from the wild is prohibitive, when any considerable acreage is involved. In addition, transplantation is of doubtful value in many cases, since the transplants require as long a time for full recovery as would be needed for seed-produced stock to come to maturity. Cornelius, 1946, Elwell, 1945, and other workers have used direct seeding as a means of restoring prairie in Kansas and Oklahoma with considerable success. A knowledge of germination behavior is useful for such work, since seeding rates and planting season may be adjusted to the species employed.

Two rather complete studies of the germination of prairie plants have been published (Blake, 1935; Tolstead, 1941) and, in addition, there are many references in the literature to the germination of occasional species. The total information, however, is still too small to permit of meaningful generalization or summary. In large part, this is occasioned by the great differences in behavior of the same species collected in different parts of the prairie region, and by the extreme differences sometimes shown by a single species collected at one place in different years. Most of the previous studies have been conducted in the center of the prairie area. The results presented here illustrate the behavior of species in the eastern ecotone.

Materials and Methods

The species used are all present in prairie remnant areas in southern and western Wisconsin (Curtis and Greene, 1949). Some of them (*Aster novae-angliae, Monarda fistulosa* and others) are not restricted to the prairie, either in Wisconsin or elsewhere, but have a general range covering several plant associations. Others (such as *Agoseris cuspidata, Brauneria pallida,* and *Psoralea esculenta*) are true prairie plants, as shown both by their local and com-

* Contribution from the University of Wisconsin Arboretum. Journal Paper No. 14.

plete ranges. A few, such as *Besseya bullii*, are restricted to the prairie peninsula and its surrounding oak opening savannas. All seeds used were collected in Wisconsin, usually in the southern tier of counties. Taxonomic nomenclature is the same as that of Curtis and Greene (1949). Seed was collected when ripe in the field, and stored at room temperature until planted. In the cases here reported the seed was planted within 6 months following collection (one exception), often much sooner. All tests were made in the period 1937 to 1948.

In certain instances, where it was desired to obtain a maximum number of seedlings for transplantation studies, carefully selected seed was used. The mode of selection depended on the seed concerned, e.g., in the case of *Lilium* where the seed coats are thin and papery the presence of an embryo was verified by the examination of the seed by transmitted light. In the case of seeds like those of *Liatris*, where the seed coat is thin, but the seed itself is relatively thick, a gentle pressure on the seed coat was sufficient to show whether seed was well filled or not. In Leguminosae, such as *Baptisia* or *Psoralea*, where the seed coat is very hard, it was assumed that the seed was well filled if it was plump and rounded and the coats of a particular batch were of uniform color.

Seeds with thick and hard coats must usually be scarified before planting, i.e., the seed coats must be broken, in order to obtain good germination within a reasonable period. Most of the Leguminosae have seeds of this type. For this study, small seeds were scarified by rubbing them between pads of sandpaper, while large seeds with very thick coats were scarified by filing through the coats of the individual seeds, a tedious procedure, but necessary for uniform results.

Seeds were planted using the following materials and procedure: Flats, in most cases 16 in. long, 5 in. wide, and 4 in. deep were filled with a mixture of two-thirds prairie loam soil (usually Dodgeville silt loam) and one-third coarse sand to a depth of 3 inches. Seeds were counted and planted at suitable depths and intervals in marked rows. The soil was carefully compacted over the seeds and the flats were watered moderately. Fine, clean quartz sand was then sprinkled in a thin layer over the soil surface, as a measure designed to reduce damping-off. The volume and weight of the seed mass, as compared with the volume of soil in the flat, was, in all these tests, negligible. In some instances standard large flats were used, but these were filled to the same depth, and since correspondingly more seed was planted in them, volume relations were about the same. It is probable that the amount of soil becomes important only as seedlings develop and, within ordinary limits, is not of great significance for germination, provided favorable moisture conditions are maintained.

If seeds were not to be subjected to further special treatment flats were left at normal greenhouse temperature (65°-70°F), examined frequently, carefully watered (with tap water from Lake Mendota, a hard water lake) as often as necessary to maintain the soil at or near field capacity, and a record kept of the total per cent germination of the seeds over a period of two months. However, in nearly all instances at least a portion of the seed was stratified, that is to say, stored in soil at low temperature for a period following planting. Preceding stratification, the soil surface was covered with

waxed paper to prevent excessive drying during storage. The flats were then wrapped in heavy kraft paper, and were usually placed in a cold room at 40°F for a period of 2 to 3 months. Flats to be stored out-of-doors over winter were further covered with fine wire screening to prevent rodent depredations. The outdoor period was from the latter part of November to about the first of April. At the termination of the stratification period, the flats were brought into the greenhouse and handled in the same fashion as those in which the seed was not stratified.

Tests of moisture content of seeds, measurements of light intensities, records of weather conditions during the ripening of the fruits, records of size and color of fruits and several other items deemed necessary for a complete report on seed germination by Lawrence, Lawrence and Seim (1947) were not made in this study. Such information is particularly valuable in a definitive study of the germination of a single species, but was impossible to obtain in a survey of the type reported here.

RESULTS AND DISCUSSION

The results of the germination tests are given in Tables I to IV. Additional species were tried under similar conditions but no germination was obtained. These included unselected seeds of *Helianthemum* sp., *Lilium michiganense*, *Lythrum alatum*, *Oenothera biennis*, and *Sisyrinchium campestre* under both stratification and non-stratification treatments, and selected seeds of *Blephilia ciliata*, *Cirsium hillii*, *Lathyrus venosus*, *Oxypolis rigidior*, *Lilium michiganense*, *Pedicularis canadensis*, *Polytaenia mutallii*, and *Solidago riddellii*, under the outside overwintering treatment. These species probably require light, two cold periods, or other special conditions not provided in the present tests, although it is recognized that their behavior might differ from year to year.

The germination percentages in tables I and II are the highest obtained for the particular species in any one trial. In many instances, germination results were extremely variable when the tests were conducted on seeds collected in different years. A few examples are shown in Table III. For some species the results for both stratification and non-stratification showed a parallel increase in favorable years. However, a few species, such as *Ratibida pinnata* and *Rudbeckia hirta* responded proportionately much less to stratification in some years than in others, indicating the year-to-year variation may involve some of the same physiological reactions that are affected by after-ripening treatments.

Scarification was used on most species that possessed an obviously hard seed coat, although thin-coated seeds of two members of the *Compositae* were also scarified. In the species shown in Table IV, the unscarified seeds gave 10% germination or less, while the scarified seeds usually germinated satisfactorily, with values up to 96%. Of the 12 species for which comparisons are possible, 5 germinated only after scarification, while for 10, scarification was either essential or beneficial. The remaining two species were not affected or were harmed by the treatment.

Stratification was a very effective treatment for many species. Of the 51 species for which comparative figures are available, 39.2% germinated only after stratification and 33.3% gave germination values which were more than 50% higher than those obtained with no cold treatment. This total of 72.5% which benefited from stratification is of course not an absolute figure, since many borderline cases might be revised on further trials in other years, but it may be assumed that between two-thirds and three-fourths of the Wisconsin prairie species are favorably affected by stratification. Stratification prevented any germination in 9.8% of the species and retarded germination (values more than 50% less than in the non-stratification control) in 3.9%, for a total of 13.7% in which stratification was harmful. The remainder of the species, 13.9%, showed no effect from stratification, in that both values were within 50% of each other.

Certain generalizations as to the effect of stratification can be made on the basis of taxonomic relationships. Thus, most grasses were benefited, with only one species (*Sporobolus heterolepis*) which showed no effect. Most of the composites were similarly benefited with only one species (*Solidago nemoralis*) which was harmed and this is of doubtful significance because of the low values. Members of the *Ranunculaceae* seemed to be unaffected by stratification as shown by 3 species. No generalizations can be drawn about the species which are definitely harmed.

A general comparison of the behavior of groups in response to stratification is given in Table V. When the total species complement in each study is divided on a percentage basis into groups showing the four types of response, the results are unusually uniform as between two previous studies of prairie plants (Blake '35, Tolstead '41) and the present study. A greater percentage of Wisconsin prairie plants appear to be dependent upon stratification for germination than do the Nebraska plants, but the total percentages which respond favorably (sum of essential and beneficial groups) are very similar, viz 67.6%, 72.5% and 85.8%. In spite of the fact that Nichols ('34) used a very heterogeneous group of seeds (including alpine, boreal forest, deciduous forest, and prairie plants) his results are in close harmony with the results for prairie species only. This is especially true in the case of species which were adversely affected by stratification, where the results of all four investigations lie within the narrow range of 13.5% to 14.3%.

SUMMARY

The germination of seeds of 91 species of prairie plants, collected on prairie remnants in Wisconsin, was studied through the use of stratification and scarification techniques. In a group of 51 species stratification was beneficial for 73% and harmful for 14%, while in a group of 12 species, mostly with hard seed coats, scarification was beneficial for 83% and harmful for 8%. Germination values for the same species under comparable conditions fluctuated greatly for seeds collected in different years. In some cases this fluctuation appeared to be related to the same factors as are affected by stratification, since the variation was greater in the stratified seeds than in the non-stratified.

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TABLE I.—Effect of Stratification on Seed Germination. Seeds not scarified or otherwise treated.

Name of Plant	No. of Months Stratified	Germination Percentage		Date Seed Collected
		Stratified	Unstratified	
Acerates viridiflora	1	73	0	Aug. 1948
Andropogon furcatus	2	16	5	Oct. 1940
Andropogon scoparius	3	16	0	Oct. 1940
Anemone cylindrica	2	20	18	Aug. 1941
Anemone patens	2	90	70	May 1946
Apocynum androsaemifolium	2	56	36	Sep. 1946
Apocynum cannabinum	3	0	10	Oct. 1940
Asclepias syriaca	2	100	62	Oct. 1940
Asclepias tuberosa	3	54	90	Sep. 1938
Asclepias verticillata	1	40	0	Sep. 1940
Aster ericoides	2	8	8	Oct. 1940
Aster laevis	2	16	16	Oct. 1940
Aster novae-angliae	2	12	4	Oct. 1940
Baptisia leucantha	3	18	8	Sep. 1941
Besseya bullii	3	0	2	Jul. 1941
Bouteloua curtipendula	1	3	0	Sep. 1940
Cacalia tuberosa	2	0	16	Sep. 1941
Castilleja sessiliflora	2	3	0	Oct. 1946
Ceanothus americanus	2	12	6	Sep. 1940
Dodecatheon meadia	2	44	0	Jul. 1941
Elymus canadensis	2	92	25	Sep. 1940
Eryngium yuccifolium	2	40	0	Sep. 1946
Galium boreale	2	15	15	Aug. 1946
Gentiana andrewsii	3	28	0	Oct. 1941
Gentiana puberula	3	50	0	Oct. 1941
Geum triflorum	3	64	50	Jun. 1941
Heuchera sp.	2	34	16	Jul. 1941
Kuhnia eupatorioides	2	56	12	Oct. 1946
Liatris aspera	2	29	0	Sep. 1940
Liatris ligulistylis	3	42	26	Sep. 1941
Liatris pycnostachya	3	51	0	Aug. 1938
Monarda fistulosa	2	15	27	Sep. 1941
Phlox pilosa	3	10	2	Jul. 1940
Polygala senega	2	5	0	Jul. 1941
Polygonatum biflorum	2	80	0	Sep. 1940
Potentilla arguta	2	21	6	Oct. 1940
Ratibida pinnata	3	60	1	Sep. 1940
Rudbeckia hirta	3	46	0	Oct. 1948
Saxifraga pennsylvanica	3	0	95	Jul. 1941
Silphium integrifolium	3	36	6	Sep. 1941
Silphium laciniatum	2	25	0	Oct. 1938
Solidago nemoralis	3	0	2	Sep. 1940
Solidago rigida	1	24	4	Oct. 1946
Solidago speciosa	2	16	4	Oct. 1940
Sorghastrum nutans	3	16	0	Oct. 1940
Sporobolus heterolepis	2	53	42	Sep. 1946
Stipa spartea	1	10	0	Jul. 1946
Thalictrum dasycarpum	3	6	0	Oct. 1940
Valeriana edulis	3	9	0	Jun. 1948
Vernonia fasciculata	3	40	16	Oct. 1940
Zizia aptera	2	6	0	Aug. 1946

TABLE II.—Germination of Selected Seed Overwintered Out-of-doors.

Name of Plant	Germination Percentage	No. of Months Stratified	Date Seed Collected
Acerates floridana	50	4	Sep. 1947
Acerates viridiflora	32	4	Sep. 1947
Agoseris cuspidata	56	4	Jun. 1947
Anemone cylindrica	10	4	Oct. 1947
Anemone patens	11	3	May 1946
Asclepias ovalifolia	77	4	Sep. 1947
Asclepias sullivantii	89	5	Sep. 1946
Aster ptarmicoides	34	4	Oct. 1947
Brauneria pallida	66	–	Sep. 1944
Bromus kalmii	85	5	Sep. 1946
Cacalia atriplicifolia	99	5	Oct. 1945
Cacalia suaveolens	77	5	Sep. 1945
Cacalia tuberosa	42	5	Sep. 1945
Eryngium yuccifolium	56	5	Aug. 1944
Gentiana puberula	High	5	Oct. 1946
Geum triflorum	69	5	Jun. 1944
Helianthus occidentalis	25	5	Oct. 1944
Helianthus rigidus	22	5	Oct. 1944
Kuhnia eupatorioides	66	5	Oct. 1944
Liatris aspera (late blooming)	48	5	Oct. 1945
Liatris cylindracea	68	4	Oct. 1947
Liatris ligulistylis	73	5	Oct. 1946
Lilium philadelphicum *var.* andinum	77	5	Sep. 1945
Parthenium integrifolium	70	5	Sep. 1944
Petalostemum purpureum	26	5	Sep. 1944
Potentilla arguta	High	4	Aug. 1947
Prenanthes racemosa	100	4	Oct. 1947
Rudbeckia subtomentosa	22	4	Sep. 1947
Silphium laciniatum	96	5	Oct. 1944
Silphium perfoliatum	88	5	Oct. 1945
Silphium terebinthinaceum	94	5	Oct. 1944
Solidago speciosa	27	5	Oct. 1945
Sporobolus heterolepis	43	5	Sep. 1945
Valeriana edulis	51	5	Jun. 1946
Zizia aptera	51	5	Jul. 1946

TABLE III.—Variations in germination of seeds collected in different years.

Name of Plant	Year Seed Collected	Germination Percentage	
		Stratified	Unstratified
Anemone patens	1937	—	62
	1946	98	40
Asclepias tuberosa	1938	54	90
	1941	14	2
Baptisia leucantha	1940	14	8
	1941	18	8
Dodecatheon meadia	1940	38	0
	1941	44	0
	1942	35	0
Elymus canadensis	1937	—	95
	1940	92	25
Geum triflorum	1937	—	80
	1940	—	14
	1941	64	50
Liatris pycnostachya	1938	51	0
	1941	20	0
Phlox pilosa	1940	10	2
	1941	2	0
Ratibida pinnata	1940	60	1
	1941	48	30
	1946	7	0
Rudbeckia hirta	1940	0	14
	1941	18	10
Saxifraga pennsylvanica	1941	0	95
	1946	0	6

TABLE IV.—Effect of Scarification on Seed Germination.

Name of Plant	Germination Percentage Stratified	Not Scarified	Months Scarified	Date Seed Collected
Astragalus canadensis	96	–	3	Sep. 1941
Astragalus canadensis	33*	1*	5	Aug. 1945
Baptisia leucantha	10	4	5	Aug. 1944
Baptisia leucophaea	2	0	5	Aug. 1944
Baptisia leucophaea	30	–	4	Aug. 1947
Camassia esculenta	48	0	3	Jun. 1948
Lespedeza capitata	66	–	2	Oct. 1940
Lespedeza capitata	64*	0*	–	Oct. 1940
Lithospermum croceum	15	0	2	Jul. 1946**
Psoralea esculenta	56	1	4	Aug. 1947
Sanicula marilandica	82	–	3	Oct. 1948
Silphium laciniatum	25*	2*	2	Oct. 1938
Silphium terebinthinaceum	34	0	3	Oct. 1948
Stipa spartea	10	10	3	Jul. 1940
Tephrosia virginiana	22	4	3	Sep. 1941
Zizia aptera	0	5	3	Sep. 1941

* Not stratified.
** Seeds stored for 2 yrs. in air at room temperature.

TABLE V.—Relative effect of stratification as shown by percentage of total number of species responding in various ways.

Response	Greene & Curtis Wis	Tolstead Neb.	Blake Neb.	Nichols Conn.
Germinated only after stratification	39.2%	28.6%	16.2%	16.3%
Germination better after stratification	33.3	57.2	51.4	39.7
Sub Total	72.5	85.8	67.6	56.0
No effect of stratification (1.5:1 to 1:1.5)	13.9	—	18.9	30.5
Stratification harmful to germination	13.7	14.3	13.5	13.5
No. of species	51	28	37	141

A Contribution to Our Knowledge of Wild Flora of Mt. Ovando

Eizi Matuda
Matuda Herbarium, Escuintla, Chiapas, Mexico

Mt. Ovando rises at latitude 15°-25′ N. and longitude 92°-36′ W. of Greenwich, in the jurisdiction of Escuintla, Soconusco District, State of Chiapas, southern Mexico, as one branch of the Sierra Madre pushing its way to the so-called "Gran Valle de Soconusco" and has an elevation of 2330 meters. There is no record before 1934 as far as I am aware, of botanical exploration of this mountain, though the flora is a very interesting and valuable one. I have discovered on this mountain one genus and 45 species new to science and 15 other species, two genera and one family new to the Mexican flora.

Constant and intensive exploration for many years by the Chicago Natural History Museum and by other institutions in the U. S. A. and Europe has thrown considerable scientific light on the floral aspects of Central America. Now it seems to me it is necessary to investigate the nature of the flora of Chiapas, which is in a transitional zone between true Mexican and true Central American elements.

The present contribution is to be regarded as a preliminary report by the writer of the local flora in one portion of the State. The preparation of an eventual "Flora of Chiapas" is the life-long ambition of the writer.

The present paper comprises an annotated list of 791 species and varieties in 476 genera and 122 botanical families.

The entities are grouped as follows:

	Families	Genera	Species	Vars. & Sub-spp.
Pteridophyta	3	21	37	—
Gymnospermae	4	5	5	—
Dicotyledoneae	103	374	608	10
Monocotyledoneae	12	76	127	4
Total	122	476	777	14

The sequence of families followed in this paper is that of Engler-Gilg, Engler-Diels System with slight modifications by myself. The monocotyledons are placed after the dicotyledons. The enumeration is based on the specimens preserved in the Matuda Herbarium, all collected by the writer between 1934 and 1947, and consequently all numbers cited hereafter are collection numbers of E. Matuda.

One complete set of specimens is deposited in the herbarium of the University of Michigan. Other incomplete sets are at the U. S. National Herbarium, Chicago Natural History Museum, Gray Herbarium of Harvard University, Instituto de Biologia de Mexico, Direccion General de Agricultura of Mexico, University of California, and Southern Methodist University.

ACKNOWLEDGEMENT

It is a pleasure to acknowledge the generous and valuable assistance rendered the writer by the following distinguished specialists in the identification of material of the groups in which they are most interested: Dr. P. C. Standley, Dr. H. N. Moldenke, Dr. W. R. Maxon, Dr. Carl Epling, Dr. Charles Schweinfurth, Dr. C. V. Morton, Dr. R. E. Woodson, Jr., Dr. L. B. Smith, Dr. S. F. Blake, Dr. J. R. Swallen. The greater part of the residue of the collection was named by Dr. C. L. Lundell, to whom the writer expresses his special thanks. And finally grateful acknowledgement is made to Carlos Ordoñez, faithful field assistant.

SELAGINELLACEAE

Selaginella cuspidata Link.—On dry or wet rocks, at 1700 m. alt., No. 230, No. 4219.

Selaginella Martensii Spring.—On wet stream banks mostly exposed, at 1000-1500 m. alt., No. 228.

Selaginella pilifera A. Br.—At wet edge of forest or on moist rock at 1000-2300 m. alt., No. 185.

SCHIZAEACEAE

Lygodium polymorphum (Cav.) H.B.K.—At the foot of the mountain, in thickets, without number. Local name: "Crespillo."

HYMENOPHYLLACEAE

Hymenophyllum polyanthis Sw.—On trunks in wet forest at 1500-2000 m. alt., No. 885.

Trichomanes radicans Sw.—Mostly on trunks in wet forest, at altitude of 1000 m., No. 185.

POLYPODIACEAE

Adiantum adicola Libm.—In open thickets, at 1500 m. alt., No. 887.

Adiantum trapesiforme L.—At the foot of the mountain, in wet forest, No. 190.

Asplenium achilleaefolium (M. & G.) Liebm.—In cycas-land, at 1000 m., on the north slope, No. 2637.

Asplenium uniseriale Raddi.—In the broadleaf zone at 1500 m., in wet forest, No. 885.

Athyrium achilleifolium (M. & G.) Fée.—In wet forest, at 900 m. alt., No. 4173.

Blechnum fraxineum Willd.—At the foot of the mountain, in dry forest, No. 188.

Diplazium denticulosum Desv.—At the foot of the mountain, in moist forest, No. 183.

Diplazium neglectum (Karst.) C. Chr.—In wet forest, at 1800 m., on the western slope, No. 3935.

Diplazium plataginifolium (L.) C. Chr.—In wet forest or along streams, at 1000 m. alt., alt., No. 889.

Dryopteris panamensis (Presl) C. Chr.—From the foot up to 1500 m. alt., in wet forest, No. 189.

Dryopteris patens (Sw.) Kuntze.—Mostly in low forest, at 1500 m. alt., No. 199.

Elaphoglossum gratum (Fée) Moore.—At 1500 m. alt., on trunks in wet forest, No. 2584.

Hemionitis pinnatifida Baker.—At the foot of the mountain, in wet or moist thickets, No. 2128

Notholaena bonariensis (Willd.) C. Chr.—On rocks, at 1500 m. alt., on west slope, No. 197.

Odontosoria schlechtendalii (Presl) C. Chr.—In dry sand pinaland, at 1700 m. alt., No. 223.

Polypodium angustifolium Sw.—Mostly on trunks in wet forest, at 1500 m. alt., No. 882.

Polypodium augustum (H. & B.) Liebm.—Mostly on trunks or on rocks in wet forest, at 2000 m., No. 883.

Polypodium Lindenianum Kunze.—In pineland, in Cycas-land at about 1000-1500 m. alt., No. 237.

Polypodium loriseum L.—Mostly on trunks in wet forest, at 1500 m. alt., No. 891.

Polypodium Lowei C. Chr.—In wet forest of west slope, at 1000-1700 m. alt., No. 890.

Polypodium sanctae-rosae (Max.) C. Chr.—Mostly on rocks in open thickets, at 2300 m. alt., No. 888.

Polypodium serpentinum Chr.—At the foot of the mountain, in wet forest, No. 207.

Polypodium triseriale Sw.—At the foot of the mountain, along stream side, No. 897.

Polystichum maricatum (L.) Fée.—In open forest of broadleaf zone, at 1000 m. alt., No. 2066.

Pteris coriaceae Desb.—At 500-1500 m., in wet forest, No. 2065.

Pteris quadriaurita Rentz,—Very common at edge of streams or in wet forest, No. 200.

Rhipidopteris peltata (Sw.) Schott.—Mostly on trunks in wet advanced forest, at 1000-2000 m. alt., No. 1859.

Scoliosorus ensiformis (Hook.) Moore.—On trunks on rocks, at 500-1500 m. alt., No. 214.

Struthiopteris ensiformis (Liebm.) Broadh.—Mostly on trunks, in wet forest, at 1100-1700 m. alt., No. 4192.

Vittaria filifolis Fée.—Mostly on trunks in wet forest, at 1500 m. alt., No. 215, No. 884, No. 4158.

CYCADACEAE

Ceratozamia Matudai Lundell.—At 1000 m. alt., on the north slope, mixed with Zamia sp. (type locality), No. 2645, No. 2646.

Zamia sp.—From the foot of the mountain up to 1000 m., in dry thickets, No. 105.

PODOCARPACEAE

Podocarpus Matudai Lundell.—At 2000 m. alt., in dry or wet zone, No. 956, No. 1847. The type locality is Mt. Pashtal (No. 698). The species is distributed in the Sierra Madre, and Cerro Boquerón. Local name: "Tabla."

PINACEAE

Pinus teocote Schl. & Cham.—At altitude of 1500-2200 m., not very abundant, No. 870.

CUPRESSACEAE

Cupressus Benthamii Endl.—At 2000-2300 m. alt., not abundant, No. 291.

PIPERACEAE

Peperomia pellucida (L.) H.B.K.—On wet rocks in advanced forest, No. 846, No. 2175

Peperomia umbilicata R. & P.—On wet rocks at 1000-1500 m. alt., in rainy season, No. 1857.

Piper auritum H.B.K.—In streams, at 200-700 m. alt., No. 16617.

Piper multinervium Mart. & Gal.—Wet thickets and forest, at 140-500 m. alt., No. 1042.

CHLORANTHACEAE

Hedysmum artocarpus Solm.—In wet forest, at altitude of 1500-1700 m., No. 405, No. 660.

SALICACEAE

Salix chilensis Molina.—On river beach, No. 869.

MYRICACEAE

Myrica mexicana Willd.—On the middle slope at 1500 m. alt., No. 1343-B.

BETULACEAE

Alnus arguta (Schlecht.) Spach.—In secondary growth on sandy ridges at 1500 m. alt., No. 2818-B.

Carpinus caroliniana Walt.—On sandy rocky slope at 2000 m. alt., No. 1855, No. 2561.

FAGACEAE

Quercus acatenangensis Trel.—At 1500-2000 m., in wet forest, on wet slope, No. 296.

Quercus Benthami A.DC.—At 1700-2000 m. alt., on the west slope, No. 3935.

Quercus boqueronae Trel.—At 1600-2200 m., in wet forest of the western slope, No. 1824, No. 1823.

Quercus conspersa Benth.—On the west slope, in wet forest, at 1000-1500 m. alt., No. 3927.

Quercus duratifolia C. H. Muller.—At 2000 m. alt., in wet forest (type locality), No. 289, No. 1827, No. 2073.

Quercus Langlassei Trel.—In open forest at 1500 m., No. 2073, No. 2102.

Quercus ovandensis Matuda; sp. nov.—Lepidobalanus-Corrugatae. Arbor excelsa, ramulis 3-7 mm. cinereis, crassis glabris, lenticellis elevatis notatis; gemmis 3 mm. longis glabris, brunneis nitidis, ovoideis; folia decidua coriacea breviter petiolata; petiolo gracili 1-1.7 cm. longo glabro badio; lamina lanceolata oblonga 7-13 cm. longa 2.5-4 cm. lata longe sensimque attenuata, basi ipsa anguste rotundata vel cuneata, glabra lucida; venis utirinque 10-13 subtus prominentibus; margine foliorum toto depresso-serrato. basin versus solum non serrato; fructu annuo pedunculato, pedunculo crasso 3-7 mm. longo, 3-4 mm. diam.; cupula depresso-semihemisphaerica magna 4.5-5 cm. lata 2.5 cm et ultra alta, squamis multiseriatis triangulari-ovatis, anguste acuminatis dorso densissime sericeis; glans excelsa matura ca. 5.5-6 cm. alta atque 3-3.5 cm. diam., oblonga ellipsoidea, ad apicem saepe rotundata, dense seriseo-tomentosa; inflorescente non visi.—A large tree 35 mm. tall, the trunk 1 m. in diameter. The acorn is included to 1/3-1/4 of its length by the cup. Local name: "Chicharo grande".—Mexico; Chiapas, in dry mixed forest on the south slope (of Mt. Ovando), at 1000 m. alt., near coffee plantation of Finca California, 20 km. northeast of Escuintla, June 2, 1948; Matuda No. 17835; type in Matuda Herbarium, isotypes in the Instituto de Biologia of Mexico, and Chicago Natural History Museum.

A new addition to the known large-fruited Central American oaks, and scarcely to be confused with any of the species of this group described by Cornelius H. Muller in his very fine monograph of the Central American species of *Quercus*.

Quercus Skinneri Benth.—In mixed forest, south slope, at 900 m. alt., No. 17936.

ULMACEAE

Trema micrantha (L.) Blume.—At altitude of 300-500 m., in sunny secondary growth, No. 1790.

MORACEAE

Castilla elastica Cerv.—At the foot of mountain, in advanced forest, at less than 500 m., without number. Local name: "Palo de Hule".

Cecropia obtusifolia Bertoloni.—At the foot of the mountain, mostly in secondary growth, up to 700 m. alt., in thickets, No. extra. Local name: "Guarumbo." Common and characteristic tree almost throughout the Pacific plains.

Coussapoa Purpusii Standl.—In wet forest, at 700 m., No. 446.

Dorstenia contrajerba L.—In wet forest from the foot of the mountain, up to 1500 m. alt., No. 651. Local name: "Contraherba".

Ficus costaricana (Liebm.) Mig.—At 200-500 m. alt., in wet zone, No. 104. Local name: "Mata palo".

Ficus glabrata H.B.K.—At river side, at foot of the mountain, No. 17411. Local name: "Amate".

Ficus Hemsleyana Standl.—At foot of the mountain, No. 2026. Local name: "Chile Amate".

Ficus radula Willd.—At the foot of the mountain, in woods, No. 2168.

Sahagunia mexicana Liebm.—In advanced forest, at an altitude of 700 m., No. 4023.

Trophis chiapensis Brandeg.—At 700-1000 m. alt., in wet forest, No. 3933.

Trophis cuspidata Lundell.—At 700-1000 m., in advanced forest (type locality), No. 1051.

Trophis Matudai Lundell.—At an altitude of 1000 m., in advanced forest (type locality) No. 576, No. 2091, No. 3978, No. 2979, No. 2648, No. 4018.

Trophis racemosa (L.) Urban.—At 300-500 m., in advanced forest, No. 443, No. 4022, No. 2598. Local name: "Jucite".

URTICACEAE

Boehmeria caudata Sw.—In wet forest, at edge of brook, at the foot the mountain, No. 113-B.

Myriocarpa longipes Liebm.—Along brook side, at an altitude of 1800 m., No. 2099.

Phenax hirtus (Sw.) Wedd.—In wet forest, along brook side, up to 1000 m., No. 3965.

Pehnax mexicanus Wedd.—Along brookside, up to 1500 m. alt., No. 112.

Phenax rugosus (Poir.) Wedd.—Along brookside, up to 1000 m. alt., No. 1747.

Pilea quercifolia Killip.—Up to 1500 m. On wet rocks along brookside, No. 2573.

Pilea quichensis Donn. Sm.—Up to 500-1000 m., at edge of brook, No. 103.

Urera caracasana (Jacq.) Griseb.—In wet sandy thickets, up to 200-2000 m. alt., No. 115, No. 3956. Local name "Chichicaste".

OLACACEAE

Heisteria acuminata B. & H.—In advanced forest, at 1200 m. alt., No. 959.

Ximenia americana L.—At altitude of 1000-1800 m., No. 563, No. 2180, No. 2625.

LORANTHACEAE

Antidaphne viscoidea P. & E.—A Parasite on tree. At 2000 m. alt., No. 3997; at 150 m. alt., in woods, No. 1049.

Oryctanthus cordifolius (Presl.) Urb.—At the foot of the mountain, on tree, in open forest, No. 1803.

Phoradendron nervosus Oliver.—At the foot of the mountain, on trees, No. 826.

Phoradendron piperoides (H.B.K.) Trel.—At 1700 m. alt., on trees, No. 4186.

Struthanthus deppeanus (C. & S.) Blume.—At 1500 m., in advanced forest, on trees, No. 661.

Struthanthus escuintlensis Lundell.—At the foot of the mountain, up to 300 m., No. 4185.

Struthanthus Matudai Lundell.—At 1700 m., on trees (type locality) No. 1808.

Struthanthus orbicularis (H.B.K.) Blume.—At the foot of the mountain, on trees, No. 2604.

ARISTOLOCHIACEAE

Aristolochia grandiflora Sw.—At the foot of the mountain, in moist thickets, No. 494. Local name: "Sombrero de don Zope".

Aristolochia maxima L.—At the foot of the mountain, No. 2138. Local name: :"Guaco".

Aristolochia pilosa H.B.K.—At the foot of the mountain, in open thickets, No. 2234. Local name: "Curarina".

MITRASTEMONACEAE

Mitrastemon Matudai Yam.—At 1500-2000 m. alt., in oak forest, parasite on horizontal roots of *Quercus boqueronea* (type locality) No. 1-E.

BALANOPHORACEAE

Helosis mexicana Liebm.—Parasite, on the west slope, at 700-1500 m. alt., in wet forest, No. 4167.

POLYGONACEAE

Coccoloba escuintlensis Lundell.—At the foot of the mountain and up to 500 m. alt., (type locality), No. 413, No. 4143, No. 4145, No. 2002. Local name: "Carnero".

Coccoloba Schiedeana Lindau.—At the foot of the mountain, in sunny thickets, No. 2028. Local name: "Papaturro".

Polygonum punctatum Ell.—At the foot of the mountain, at wet edge of swamp, No. 2174.

Triplaris americana L.—In secondary growth or secondary forest, at the foot of the mountain, No. 814, No. 277. Local name: "Mulato".

CHENOPODIACEAE

Chenopodium ambrosiodides L.—Cultivated, often escaped, No. 4565-B. Local name: "Epazote".

Chenopodium murale L.—In secondary growth, on wet slope, No. 4250.

AMARANTHACEAE

Alternanthera gracilis (Moq.) Loes.—At an altitude of 1000 m., in the edge of advanced forest, No. 782.

Amaranthus hybridus L.—At the foot of the mountain, No. 1043.

Chamissoa altissima (Jacq. (H.B.K.—At 500 m. alt., in secondary growth, No. 390.

Iresine frutescens Moq.—At the foot of the mountain and up to 700 m. alt., No. 893.

Iresine Herrerae Blake.—In wet forest on the west slope, No. 969.

Iresine nigra Uline & Bray—At 1500 m. alt., in advanced forest, No. 971.

NYCTAGINACEAE

Boerhavia coccinea Mill.—At the foot of the mountain, at edge of brook, No. 954.

Neea turbinata Lundell.—At the foot of the mountain, in sandy thickets (type locality), No. 647, No. 913, No. 2615.

PHYTOLACCACEAE

Petiveria alliaceae L.—At the foot of the mountain, in secondary thickets, No. 139.

Phytolacca icosandra L.—At 1000-2300 m. alt., in wet thickets, No. 873.

Rivina humilis L.—At 1000-1700 m. alt., in secondary sandy thickets, No. 643, No. 2190.

PORTULACACEAE

Talinum paniculatum (Jacq.) Gaertn.—At 500-1000 m. alt., in secondary sandy growth, No. 561, No. 4202.

CARYOPHYLLACEAE

Arenaria lanuginosa (Michx.) Rohrb.—At 1300 m. alt., in wet forest edges, No. 475.

Drymaria cordata Willd.—At 2000 m. alt., in wet forest edges, No. 2287.

Drymaria hypericifolia Briq.—At 2000 m. alt., in wet forest edges, No. 4000.

Stelleria ovata Willd.—At 1900 m. alt., in wet forest edges, No. 2199.

RANUNCULACEAE

Clematis grossa Benth.—At 1000 m. alt., in moist thickets, No. 3989. Local name: "Cruz Mecate".

Thalictrum sp.—In moist thickets and forest, No. 555.

BERBERIDACEAE

Mahonia chiapensis Lundell.—In wet forest, at 2000 m. alt., (type locality), No. 3996.

MENISPERMACEAE

Cissampelos grandifolia Trian & Planch.—At the foot of the mountain, No. 1800.

Cissampelos parerira L.—At the foot of the mountain in sandy thickets, No. 2246.

MAGNOLIACEAE

Drimys Winteri Forst.—In wet forest at an altitude of 2000 m., No. 4287.

ANONACEAE

Cymbopetalum penduliflorum Baill.—On the foot of the mountain, in wet forest, No. 625. Local name: "Orejuela".

Desmopis lanceolata Lundell.—At 2000 m. alt., in dry forest (type locality), No. 2299.

Rollinia mucosa (Jacq.) Baill.—In sandy thickets, common in lowland, No. 1084. Local name: "Anonita".

MONIMIACEAE

Mollinedia viridiflora Tul.—At 1900 m. alt., in advanced forest, No. 442.

Siparuna nicaraguensis Hemsl.—At the edge of the advanced forest, at the foot of the mountain, No. 2528.

LAURACEAE

Nectandra reticulata (R. & P.) Mez.—At the foot of the mountain, moist or dry forest, No. 383. Local name: "Tepeaguacate".

Ocotea escuintlensis Lundell.—At the foot of the mountain, at 300 m. alt., (type locality), No. 654. Local name: "Pimientillo".

Ocotea Matudai Lundell.—At 1800 m. alt., in wet advanced forest (type locality), No. 4221, No. 4188.

Ocotea ovandensis Lundell.—At 1500-2000 m. alt., in wet advanced forest (type locality), No. 4368, No. 444, No. 1012, No. 1839.

Persea flavifolia Lundell.—At 2000 m. alt., in wet advanced forest (type locality) No. 1821.

Persea Matudai Lundell.—On the northern slope, 1700 m., in moist or dry advanced forest (type locality), No. 1380.

Phoebe acuminatissima Lundell.—In wet forest, at an altitude of 1900 m., (type locality), No. 2107, No. 569.

Phoebe chiapensis Lundell.—In wet forest of the west slope, No. 2064.

Phoebe mexicana Meissn.—At the foot of the mountain, in forest, No. 2632.

Phoebe obtusata Lundell.—On the northern slope, at an altitude of 1300 m., in moist forest, No. 3986.

Phoebe Pittieri Mez.—At the foot of the mountain, in advanced forest, No. 2252.

Phoebe platyphylla Lundell.—On the north western slope, at 800 m. alt., No. 1930.

PAPAVERACEAE

Bocconia arborea S. Wats.—At an altitude of 1800 m., in secondary growth, No. 668, No. 2917.

Bocconia oblanceolata Lundell.—At 1900 m. alt., in sunny secondary growth (type locality), No. 2194.

CAPPARIDACEAE

Forchammeria Matudai Lundell.—At 900 m. alt., in advanced forest, on the western slope (type locality), No. 2650.

PODOSTEMONACEAE

Marathrum Schiedeanum Cham.—On rocks in streams at the foot of mountain, No. 600.

BRASSICACEAE

Cardamine fulcrata Greene.—In secondary growth, at 1500-2000 m. alt., No. 2576.

Nasturtium officinale R. Br.—At 1900 m. alt., in cold stream, No. 1280.

CRASSULACEAE

Brophyllum pinnatum (Lam.) Kurz.—In dry thickets, without number. Local name: "Siempre Vive".

Sedum Botterii Hemsl.—At 2000 m., in wet forest, on trees, No. 2655.

SAXIFRAGACEAE

Phyllanoma laticuspia (Turcz.) Engler.—At 1000 m., in wet forest, No. 483.

CUNONIACEAE

Weinmannia pinnata L.—At 1900-2300 m. alt., in sunny thickets, No. 403, No. 4285.

HAMAELIDACEAE

Matudeae trinervis Lundell.—At an altitude of 1800 m., in wet Fagaceae forest (type locality), No. 1843, (flower) No. 3984, (fruit).

ROSACEAE

Couepia dodecandra (DC.) Hemsl.—Common in wet forest at the foot of the mountain, No. 1090. Local name: "Sapotillo," fruit edible.

Hirtella racemosa Lam.—At 700-1900 m. alt., in moist advanced forest, No. 681.

Holodiscus fissus (Lindl.) Schlecht.—At 2200 m. alt., on open brushy limestone ridge, No. 2580.

Rubus adenotrichos Schlecht.—At 1000 m. alt., in secondary thickets, No. 4220. Local name: "Mora".

LEGUMINOSAE

Acacia angustissima (Mill.) Kuntze.—In open secondary growth at the foot of the mountain, No. 31, No. 3975.

Acacia Hindsii Benth.—Common at the foot of the mountain, in secondary thickets, No. 8. Local name: "Ishcanal".

Acacia paniculata Willd.—At 2000 m. alt., in open sunny forest, No. 1842.

Acacia riparia H.B.K.—At 2000 m. alt., on open brushy ridge, No. 2536.

Aeschynomene americana L.—At the foot of the mountain, in wet thickets, No. 53, No. 2164.

Aeschynomene hispida Sw.—At the foot of the mountain, in swampy, moist, waste land, No. 44, No. 2121.

Bauhinia Standleyi Rose.—In secondary open thickets, at the foot of the mountain, woody vine, No. 47, No. 66.

Bauhinia ungulata L.—At the foot of the mountain, in open secondary thickets, No. 60. Local name: "Pie de Venado".

Benthamantha panamensis Rydberg.—At the foot of the mountain, along open brookside, No. 32.

Calliandra confusa Sprague & Riley.—At 900 m., in secondary sunny dry thickets, No. 4169.

Calliandra chiapensis (B. & R.) Lundell.—At the foot of the mountain, in wet forest, No. 2608. Local name: "Tamarindo de monte".

Calliandra tetragona (Willd.) Benth.—At the foot of the mountain, in open secondary grassy land, No. 30.

Calopogonium brachycarpum Benth.—At the foot of the mountain, in sunny open thickets, No. 14.

Calopogonium caeruleum Benth.—At the foot of the mountain, in secondary growth or meadow, No. 10.

Canavalia hirsuta (M. & G.) Standl.—At 1250-2370 m. alt., in edge of open forest, No. 2575.

Canavalia villosa Benth.—At the foot of the mountain, in secondary thickets, No. 503, No. 2062.

Cassia biflora L.—In open wet secondary growth, at 1000 m. alt., No. 68.

Cassia leiophylla Vogel.—At the foot of the mountain and up to 500 m., or more, in secondary grassy open wet land, No. 11.

Cassia leptocarpa Benth.—At the foot of the mountain, in sunny grassy waste land, No. 40.

Cassia oxphylla Kunth.—At the foot of the mountain, in open edge of thickets, No. 29. Local name: "Candera Patria".

Cassia pilosa L.—In wet open places or along streams, at the foot of the mountain, No. 45.

Cassia reticulata Willd.—At the foot of the mountain, along open sandy streams, No. 48. Local name: "Tortuga" .

Cassia rufa Mart. & Gal.—At the foot of the mountain, along open grassy streams, No. 23, No. 27.

Centrosema Plumieri Benth.—At edge of forest or wet thickets at the foot of the mountain. No. 16.

Centrosema virginianum (L.) Benth.—In secondary growth, from the foot of the mountain up to 500 m. or more, No. 12.

Chaetocalyx Matudai Lundell.—At the foot of the mountain, in sandy sunny riverside, (type locality) No. 834; distributed as "Ch. belisensis Standl."

Cologania intermedia H.B.K.—At 500 m. alt., on open meadow, No. 5.

Crotalaria maypurensis H.B.K.—In secondary growth and open meadows, at the foot of the mountain, No. 42. Local name: "Chipilin".

Crotalaria Schiedeana Steud.—In pine woods, at 1700 m. alt., No. 4007.

Crotalaria Vitellina Ker.—In pineland, at 1700-2000 m. alt., in dry sandy soil, No. 2585.

Desmodium affine Schl.—At foot of the mountain, at edge of forest, No. 1866.

Desmodium barbatum (L.) Benth. & Oerst.—At the foot of the mountain, in sandy open riverside, No. 54.

Desmodium cinerascens Gray.—Along open sandy riverside, at the foot of the mountain, No. 38.

Desmodium infractum DC.—At the foot of the mountain, at edge of forest, No. 2123.

Desmodium palmeri Hemsl.—At the edge of advanced forest, at altitudes of 500-1000 m., No. 3.

Desmodium purpureum (Mill.) Fawc. & Rendl.—At the foot of the mountain, in open secondary growth, No. 171.

Desmodium spirale Bigel.—Along open roadside, at the foot of the mountain, No. 486.

Diphysa robinioides Benth.—From the foot of the mountain up to 1500 m., in open forest, No. 41. Local name: "Guachipilin".

Entada polystachya (L.) DC.—A woody vine, from the foot of the mountain up to 700 m., at edge of open forest, No. 4141.

Enterolobium cyclocarpum (Jacq.) Griseb.—From the foot of the mountain up to 700 m., in sandy open forest or along riverside, No. 7. Local name :"Guanacaste."

Erythrina mexicana Krukoff.—From the foot of the mountain up to 1700 m., in open forest, without number. Local name: "Zumpante."

Gliricidia sepium (Jacq.) Steud.—Common in sandy open thickets, from the foot of the mountain up to 500 m., No. 15. Local name: "Yaite."

Hymenaea Courbaril L.—In dry or wet forests from the foot of the mountain up to 800 m., No. 1426. Local name: "Guapinol."

Indigofera suffruticoas Mill.—In sunny secondary growth, at the foot of the mountain, No. 55, No. 506.

Inga edulis Mart.—From the foot of the mountain up to 500 m., mostly along sandy riversides, No. 22. Local name: "Cuil de Agua."

Inga lauriana (Sw.) Willd.—In wet forest, at the foot of the mountain, No. 46.

Inga Micheliana Harms.—From the foot of the mountain up to 1200 m., in open forest, No. 22.-B. Local name: "Chalum."

Inga paterno Harms.—In open forest, 300-700 m., No. 2070. Local name: "Caspirol."

Lonchocarpus apricus Lundell.—In open forest along the edge of river at the foot of the mountain, No. 2620, No. 4020. Local name: "Metabuey."

Lonchocarpus cochleatus (Pitt.).—From the foot of the mountain, in open forest, up to 500 m., No. 2109. Local name: "Lombricero."

Lonchocarpus hondurensis Benth.—In open sandy or moist ridges along river, at the foot of the mountain, No. 1088. Local name: "Chaperna."

Lonchocarpus minimiflorus Donn. Sm.—In open sandy thickets, No. 1801.

Machaerium latifolium (Benth.) Pittier.—A woody vine at the foot of the mountain, No. 2613.

Machaerium riparium Brandeg.—At the foot of the mountain, in brushy thickets, No. 71. Local name: "Uña de gato."

Machaerium setulosum Pittier.—From the foot of the mountain up to 500 m., in open brushy thickets, No. 2032.

Mimosa albide Humb. & Bonpl.—In dry stony thickets or in fields at the foot of the mountain, No. 21, No. 59.

Mimosa Maxonii Standl.—At the foot of mountains, in dry thickets, No. 8.

Mimosa pigra L.—In brushy marshes at the foot of mountain, No. 43.

Nissolia Nelsoni Rose.—A vine, from the foot of the mountain up to 300 m., No. 559, No. 3950.

Parosela nigra (Mart. & Gal.) Rose.—In brushy sandy thickets, at the foot of the mountain, No. 2118.

Phaseolus viridis Piper.—At the foot of the mountain, in open thickets, No. 9.

Pithecolobium Matudai Lundell.—At an altitude of 2100 m., in open forest (type locality), No. 1835.

Pithecolobium saman (Jacq.) Benth.—In open forest or along sandy sunny edges of river, at the foot of the mountain, No. 4021. Local name: "Tepenaguaste."

Rhynchosia longiracemosa Mart. & Gal.—In open thickets at the foot of the mountain, No. 72.

Rhynchosia pyramidalis (Dam.) Urban.—In dry thickets at the foot of the mountain, No. 56.

Schizolobium parahybum (Vell.) Blake.—From the foot of the mountain up to 800 m., in open forest, No. 18. Local name: "Cuchiyal."

Sesbania Emerus (Aubl.) Britt. & Wilson.—At the foot of the mountain, in swamp thickets, No. 49.

Tephrosia toxicaria (Sw.) Pers.—At the foot of the mountain, in open fields or open thickets, No. 17.

Trifolium amabile H.B.K.—At the foot of the mountain, in open fields, No. 26.

GERANIACEAE

Geranium mexicanum H.B.K.—In wet thickets at 2000 m. alt., No. 966, No. 2254. Local name: "Mano de Leon."

OXALIDACEAE

Biophytum dendroides (H.B.K.) DC.—At the edges of forests at 1000 m. alt., No. 881.

Oxalis Neaei DC.—At the foot of the mountain, in open field, No. 951.

Oxalis acuminata Sch. & Cham.—Mostly in open pineland, at 2000 m., No. 1067-B.

ERYTHROXYLACEAE

Erythroxylon tabascense Britton.—In advanced forest at 1500 m. alt., No. 1816.

RUTACEAE

Casimiroa tetrameria Millsp.—At 2000 m., in wooded ravines or on hillsides, No. 2544. Local name: "Matasano," fruit edible.

Ruta chalapensis L.—Mostly cultivated, often escaped in open thickets at 1000-2000 m., No. 1886.

Zanthoxylum Harmesinum (Loes.) P. Wilson.—At 1700 m., in moist thickets, No. 896.

Zanthoxylum melanostictum Cham. & Schl.—At 2000 m. alt., in open forest, No. 2078, No. 3921.

SIMARUBACEAE

Picramnia Matudai Lundell.—At 1500-2000 m. alt., in moist forest (type locality), No. 428, No. 3946, No. 4166.

Picrmania pistaciafolia Blake & Standl.—At 2000 m. alt., in moist forest, No. 481, No. 3937.

MELIACEAE

Cedrela mexicana M. Roem.—In wooded ravine, from the foot of the mountain up to 2000 m., No. 4464. Local name: "Cedro."

Guarea obtusata Blake.—At 800 m. alt., in wet forest, No. 903, No. 2294, No. 4168.

Guarea Trompillo C. DC.—In the wet forest, at the foot of the mountain, No. 2616. New for Mexico; reported previously only from Guatemala. Local name: "Trompillo."

Trichilia cuneata Radlk.—At the foot of the mountain, in sandy woods, No. 914.

Trichilia hirta L.—At the foot of the mountain, in forest, No. 627.

MALPIGHIACEAE

Banisteria Beecheyana (H. & A.) C. B. Rob.—At the foot of the mountain in the edge of wet forest, a woody vine, No. 412.

Banisteria laurifolia L.—A woody vine, in dry thickets at the foot of the mountain, No. 1083.

Banisteriopsis argentea (H.B.K.) C. B. Rob.—In dry thickets at the foot of the mountain, No. 578.

Bunchosia guatemalensis Niedenzu.—In moist thickets at the foot of the mountain, No. 1796.

Bunchosia lanceolata Turcz.—In dry forest, from the foot of the mountain up to 1000 m., No. 511, No. 567, No. 872, No. 2609.

Bunchosia Matudai Lundell.—At 2200 m. alt., in moist forest (type locality), No. 3924, No. 3983.

Byrsonima crassifolia (L.) H.B.K.—In open sandy thickets from the foot of the mountain up to 700 m. alt., often cultivated, No. 662.

Gaudichaudia albide C. & S.—At the foot of the mountain in dry thickets, No. 998.

Hiraea obovata (H.B.K.) Niedenzu.—In wet forest, from the foot of the mountain up to 2000 m. alt., No. 2181.

Hiraea velutina Niedenzu.—In moist forest, at 2000 m. alt., No. 1840.

Mascagnia malpighioides (Turcz.) Morton.—At an altitude of 1800 m., in wet forest, No. 478, No. 2643.

Mascagnia ovatifolia (H.B.K.) Griseb.—A woody vine, in dry thickets at the foot of the mountain, No. 868, No. 2178, No. 2629.

Stigmaphyllon Lindenianum A. Juss.—In open dry thickets at the foot of the mountain, No. 2182.

Stigmaphyllon puberum (Rich.) A. Juss.—In wet forest at 2000 m. alt., No. 2660.

Tetrapteris discolor (G.f.W.Mey.) DC.—In dry thickets at the foot of the mountain, No. 489, No. 1876, No. 434.

Tetrapteris discolor var. *lanuginosa* Niedenzu.—In advanced forest, 1900 m. alt., No. 2640.

POLYGALACEAE

Securidaca diversifolia (L.) Blake.—In open sunny pineland, at 1900 m. alt., No. 1841.

DICHAPETALACEAE

Dichapetalum chiapensis Standl.—A woody vine, in advanced forest at 2000 m. alt., (type locality), No. 679, No. 4208, No. 4006.

Dichapetalum Donnell-Smithii Engler.—In open thickets at the foot of the mountain, No. 630, No. 645. Local name: "Durasnito)."

EUPHORBIACEAE

Acalypha alopecuroides Jacq.—At the foot of the mountain in open fields or secondary growth, No. 949.

Acalypha unibracteata Muell.-Arg.—In secondary growth, at 1000 m. alt., No. 562.

Adelia barbinervis Cham. & Schl.—At the foot of the mountain in open forest, No. 2745.

Alchornea latifolia Sw.—At the foot of the mountain, in open forest, No. 1007.

Bernardia oblanceolata Lundell.—At 1900 m. alt., in advanced forest, No. 4148.

Croton arboreus Millsp.—In open forest, from the foot up to 1000 m. alt., No. 4262. Local name: "Copalti."

Croton lobatus L.—At the foot of the mountain, in secondary growth, No. 953.

Dalechampsia scandens L.—In open field at the foot of the mountain, No. 2173.

Euphorbia brasiliensis Lam.—In open fields or secondary growth, at the foot of the mountain, No. 264.

Euphorbia heterophylla L.—In open fields or secondary growth at the foot of the mountain, No. 276.

Euphorbia hirta L.—At the foot of the mountain, in open fields, No. 269.

Euphorbia pulcherrima Willd.—At 800 m. alt., in wet wooded ravine, often cultivated, No. 2082. Local name: "Arbol de Navidad."

Jatropha curcas L.—At the foot of the mountain, mostly cultivated for fences or escaped in open thickets, No. 2618. Local name: "Piñon."

Jatropha sp.—In secondary growth, from the foot of tht mountain up to 1500 m. alt., No. 284. Local name: "Mala Mujer."

Mabea occidentalis Benth.—In wet forest, from the foot of the mountain up to 500 m alt., No. 490.

Phyllanthus Niruri L.—In open fields or secondary growth at the foot of the mountain, No. 263.

Phyllanthus nobilis (L.f.) Muell.-Arg.—At the foot of the mountain, in sandy open thickets, No. 2602.

Phyllanthus Purpusii Brandeg.—At 800 m. alt., in wet advanced forest of the west slope, No. 523.

Ricinus communis L.—At the foot of the mountain, in secondary sandy field without number. Local name: "Higuerilla."

Tetrorchidium rotundatum Standl.—At the foot of the mountain, in wet ravine, No. 120. Local name: "Chonte."

ANACARDIACEAE

Spondias Mombin L.—At the foot of the mountain, in dry open forest, No. 2167. Local name: "Jobo."

Toxicodendron striata (Ruiz & Pavon) Kuntze.—In open forest, at altitudes of 1300-1800 m., No. 3934, No. 3967, No. 4187.

CELASTRACEAE

Celastrus chiapensis Lundell.—A woody vine, at 2000 m. alt., in advanced forest (type locality), No. 3944.

Celastrus vulacnicolus Donn.Sm.—At 1500 m. alt., in advanced forest, No. 1834.

Perrotelia longistylis Rose.—In wet ravine, at 2000 m. alt., No. 3982.

Zinowiewia Matudai Lundell.—In advanced wet forest, at 2000 m. alt., No. 424.

HIPPOCRATACEAE

Salacia sp.—In advanced forest, at 1000 m. alt., No. 518.

STAPHYLEACEAE

Turpinia occidentalis (Sw.) Don.—In advanced wet forest, at 1500 m. alt., No. 2267, No. 2545, No. 2658.

Turpinia paniculata Vent.—At 900 m. alt., in wet advanced forest on the western slope, No. 4165.

HIPPOCASTANACEAE

Billia hippocastanum Beyr.—In wet advanced forest, at 1700 m. alt., No. 416, No. 2638, No. 4213. Local name: "Jaboncillo."

SAPINDACEAE

Allophylus occidentalis (Sw.) Radlk.—In sandy thickets, at the foot of the mountain, No. 638.

Cardiospermum garndiflorum Sw.—At the foot of the mountain in sunny thickets, No. 601.

Cupania macrophylla A. Rich.—In dry or moist forest, at the foot of the mountain, No. 2150, No. 2606, No. 2607.

Sapindus saponaria L.—In wet forest at the foot of the mountain, No. 602.

Serjania brachystachya Radly.—At the foot of the mountain, in secondary growth, No. 487.

Serjania caracasana (Jacq.) Willd.—At the foot of the mountain, in sunny thickets, No. 2261.

Serjania cardiospermoides S. & C.—From the foot of the mountain, up to 500 m. alt., in open thickets, No. 565.

Serjania racemosa Schum.—In edges of open forest, at 1000 m. alt., No. 4013.

Serjania triquetra Radlk.—At the foot of the mountain, in sunny thickets, No. 453.

SABIACEAE

Meliosma Matudai Lundell.—In wet advanced forest, at 1500 m. alt., No. 526.

RHAMNACEAE

Gouania lupuloides (L.) Urban.—At the foot of the mountain, in secondary thickets, No. 484.

Gouania polygama (Jacq.) Urban.—At the foot of the mountain, sandy sunny thickets, No. 2285.

Rhamnus discolor (Donn. Sm.) Rose.—In advanced wet forest, at 1500 m. alt., No. 3980, No. 4150.

VITACEAE

Cissus rhombifolia Vahl.—In open moist thickets, at the foot of the mountain, No. 2166.

Cissus sicyoides L.—From the foot of the mountain up to 500 m. alt., in secondary thickets, No. 911.

Vitis tiliaefolia Humb. & Bonpl.—At the foot of the mountain, in dry thickets, No. 637.

TILIACEAE

Apeiba Tibourbou Aubl.—In open secondary growth at 700 m. alt., No. 22. Local name: "Peine de Mico."

Belotia mexicana (DC.) K. Schum. ev char.—In secondary, sunny growth, from the foot of the mountain up to 1000 m. alt., No. 2138. Local name: "Capul."

Luchea candida (DC.) Mart.—At the foot of the mountain, in sandy river bank, No. 102.

Luchea speciosa Willd.—At the foot of the mountain, in sandy dry thickets or on river-bank, No. 107.

Muntingia calabura L.—At secondary growth, at the foot of the mountain, No. 510. Local name: "Capulin," fruit edible.

Triumfetta dumetorum Schl.—At the foot of the mountain, in moist thickets, No. 99.

Triumfetta lappula L.—In wet thickets at the foot of the mountain, No. 97.

Triumfetta mexicana Turcz.—In moist secondary thickets at the foot of the mountain, No. 488.

MALVACEAE

Helicteris guazmaefolia H.B.K.—At the foot of the mountain, open secondary growth, No. 2169.

Hibiscus bifurcatus Cav.—A vine, in open thickets, at 1700 m. alt., No. 3977.

Malva parviflora L.—At 1500 m. alt, in secondary dry thickets, No. 100.

Malvaviscus populifolius Presl.—In edge of forest at 1800 m. alt., No. 3960.

Pseudabutilon spicatum (H.B.K.) Fries.—In sandy secondary thickets at the foot of the mountain, No. 88.

Sida decumbens St. Hil. & Naud.—At the foot of the mountain, in open thickets, No. 98.

Sida cordifolia L.—At the edge of dry forest, at 800 m. alt., No. 93.

Sida glomerata Cav.—From the foot of the mountain up to 1000 m. alt., in waste soil, No. 2170.

Sida rhombifolia L.—In waste ground or sandy roadside at the foot of the mountain, No. 96, No. 2114. Local name: "Escobilla."

BOMBACACEAE

Ceiba aesculifolia Britt. & Baker (?).—In open ground from the foot of the mountain up to 700 m., without number. Local name: "Ceiba."

Pachira aquatica Aubl. At the foot of the mountain, in wet swampy thickets, No. 2622. Local name: "Zapote de Agua."

STERCULIACEAE

Buettneria aculeata Jacq.—In secondary thickets, at the foot of the mountain, No. 2139. Local name: "Salsa."

Chiranthodendron pentadactylon Larréategi.—At 1900 m. alt., in wet ravine, No. 2635. Local name: "Canaco."

Guazma ulmifolia Lam.—In secondary thickets, from the foot of the mountain up to 700 m., No. 422. Local name: "Cuaulote."

Melochia bernoulliana D. Sm.—At the foot of the mountain, in secondary thickets, No. 485, No. 2129.

Sterculia mexicana R. Br.—At 1000 m. alt., in wet advanced forest, No. 3920.

Theobroma bicolor H. & B.—In wet ravine from the foot of the mountain up to 700 m., No. 16610. Local name: "Pataste."

Theobroma cacao L.—In wet forest, below 700 m., in natural growth, without number. Local name: "Cacao."

Waltheria americana L.—At the foot of the mountain, in moist secondary thickets, No. 583.

Waltheria glomerata Presl.—From the foot of the mountain up to 500 m., in secondary dry thickets, No. 603.

DILLENIACEAE

Davilla rugosa Poir.—In dry thickets, at the foot of the mountain, No. 902.

Tetracera volubilis L.—At the foot of the mountain, in dry thickets and in open forest, No. 604.

MARCGRAVIACEAE

Souroubea exauriculata Delp.—A woody vine, at 1900 m. alt., in advanced forest, No. 4146.

THEACEAE

Cleyera Matudai Kobuski.—In wet advanced forest, at 1800 m. alt., (type locality), No. 2560.

Eurya theoides (Swartz) Blume(?).—At 1800 m. alt., in advanced forest, on the western slope, No. 4154.

Symplococarpon flavifolium Lundell.—At 1600 m., alt., in wet advanced forest on the western slope (type locality), No. 696.

Ternstroemia tepezapote Schlecht. & Cham.—At 700-1500 m. alt., in wet forest, No. 641, No. 656.

GUTTIFERAE

Calophyllum brasiliense var. *rekoi* Standl.—From the foot of the mountain up to 500 m. alt., or less, in wet advanced forest, No. 1804. Local name: "Marillo."

Clusia mexicana Vesque.—At 800 m. alt., in wet advanced forest, No. 2079.

Clusia Salvinii Donn. Sm.—At 2000 m. alt. or more, in wet advanced forest, No. 652, No. 1569, No. 2665, No. 4016, No. 4017.

Rheedia edulis (Seem.) Triana & Planch.—At 800 m. alt. or more, in wet advanced forest, No. 566. Local name: "Toronjil."

BIXACEAE

Bixa orellana L.—At the foot of the mountain, in wet forest, No. 2165. Local name: "Achote de Monte."

COCHLOSPERMACEAE

Cochlospermum vitifolium (Willd.) Spreng.—At the foot of the mountain, in open sandy thickets and along riversides, No. 2063. Local name: "Punpusuche."

VIOLACEAE

Hybanthus attenuatus (Willd.) Schulz.—In secondary growth and open fields at the foot of the mountain, No. 912.

FLACOURTIACEAE

Casearia arguta H.B.K.—At the foot of the mountain, in open forest, No. 267. Local name: "Pie de venado."

Casearia javitensis H.B.K.—In wet forest at the foot of the mountain, No. 2603.

Casearia nitida (L.) Jacq.—At the foot of the mountain, in sandy thickets, No. 950.

Castaria sylvestris Sw.—At 300-500 m., in advanced forest, No. 1792.

Hasseltia guatemalensis Werl.—At 1000 m. alt., in wet forest, No. 1881, new for Mexico.

Xylosma ellipticum (Clos.) Hemsl.—At the foot of the mountain, in sandy thickets, No. 1795.

Xylosma horridum Rose.—At 900 m., in wet or moist forest, No. 522.

TURNERACEAE

Erblichia xylocarpa var. *mollis* Standl. & Steyerm.—At 1000 m. alt., on the northern slope, in advanced forest, No. 2653. Previously distributed as "E. odorata Seem."

Turnera ulmifolia L.—In sandy fields at the foot of the mountain, No. 669.

PASSIFLORACEAE

Passiflora coriacea Juss.—In dry sunny thickets, at the foot of the mountain, No. 1994.

Passiflora filipes Benth.—In dry thickets, at the foot of the mountain, No. 2132.

Passiflora ornitheura Mast.—In secondary growth, at 2000 m. alt., No. 3971.

Passiflora rugosissima Killip.—In open thickets, edge of forest, at 1800 m. alt., No. 477.

BEGONIACEAE

Begonia sp.—Probably 6 or 7 spp., but as yet unidentified.

THYMELAEACEAE

Daphnopsis flavida Lundell.—At 2000 m., in dry forest on the western slope (type locality), No. 4157.

LYTHRACEAE

Adenaria floribunda H.B.K.—In dry thickets at the foot of the mountain, No. 867, No. 2599.

Cuphea bustamanta Llav. & Lex.—In open thickets, at 1500 m. alt., No. 898, No. 2543.

Cuphea cristata Rose.—In open dry thickets, at 1300 m. alt., No. 1809, No. 3959.

Cuphea nitidula H.B.K.—In sunny dry thickets, at 1000 m. alt., No. 147.

Cuphea pinetorum Benth.—At edge of forest, at 2000 m. alt., No. 144.

Lafoensia panicaefolia DC.—In wet advanced forest at the foot of the mountain, No. 2147. Local name: "Campanillo."

COMBRETACEAE

Combretum erianthum Benth.—In sandy thickets, at 500-700 m. No. 435. Local name: "Tamborilla."

Combretum mexicanum H. & B.—In dry thickets, at the foot of the mountain, No. 420.

Terminalia exelsa Liebm.—At the foot of the mountain, No. 580, in forest. Local name: "Volador."

MYRTACEAE

Eugenia escuintlensis Lundell.—In advanced wet forest, at the foot of the mountain (type locality), No. 4144.

Psidium molle Bertol.—In open grassy fields, at 700-1000 m., No. 4403.

MELASTOMACEAE

Clidemia dentata D. Don.——In wet forest, at 1000 m. alt., on the western slope, No. 983.

Clidemia hirta (L.) D. Don.—At 1000-1500 m., in wet forest, No. 8791.

Conostegia volcanalis Standl. & Steyerm.—In wet ravine at 1500 m. alt., No. 2644. New to Mexico.

Conostegia xalapensis (Bonpl.) Naud.—At 500-1000 m. alt., on the western slope, in wet forests, No. 829.

Miconia aeruginosa Naud.—In wet forest, at 500 m., No. 825.

Miconia argentea (Sw.) DC.—In wet forest, from the foot of the mountain up to 1000 m., No. 991.

Miconia costaricensis Cogn.—In forest, at 500-1000 m. alt., No. 823.

Miconia glaberrima (Schult.) Naud.—At 1500-2000 m. alt., in advanced forest, No. 943, No. 2093.

Miconia impetiolaris (Sw.) D. Don.—In wet forest, at the foot of the mountain, No. 512.

Miconia lauriformis Naud.—At 2000 m. alt., in advanced wet forest, No. 2666, No. 3941.

Miconia mexicana (H. & B.) Naud.—In forest, at 900-1500 m. alt., No. 822.

Miconia pinetorum Naud.—In open forest, at 1000 m. alt., No. 821.

Miconia prasina (Sw.) DC.—In wet forest, at 1000 m., No. 880.

Monochaetum Deppeanum (Schlecht. & Cham.) Naud.—In wet ravine, at 1000-1500 m. alt., No. 1065.

Monochaetum pulchrum Dcne.—In wet edge of forest ,at 2000 m. alt., No. 972, No. 3947.

Monochaetum rubescens Gl.—At 1500 m. alt., in wet ravine, No. 973.

Pterolepis trichotoma (Rottb.) Cogn.—At the foot of the mountain, in dry edge of forest, No. 987.

Tibouchina longifolia (Vahl) Baill.—At 2000 m. alt., in margins of forest, No. 936, No. 970, No. 3928.

OENOTHERACEAE

Fuchsia arborescens Sims.—At 1000 m. alt., in wet ravine of forest, No. 437.

Gaura coccinea Mitt.—At the foot of the mountain, in dry thickets, No. 676.

Jussiaea erecta L.—At the foot of the mountain, in swampy waste ground, No. 673.

Jussiaea inclinata L. f.—At the foot of the mountain, in swampy or wet ground, No. 2157.

Lopezia integrifolia DC.—At 1500 m., in wet ravine, No. 697.

ARALIACEAE

Gilibertia arborea (L.) March.—At the foot of the mountain, in wet forest, No. 513, No. 1079. Local name: "Mano de Leon."

Oreopanax peltatum Linden.—At 1900 m. alt., in wet forest, No. 417, No. 4153.

Oreopanax xalapensis (H.B.K.) Planch. & Done.—At 1000-2000 m. alt., in wet forest and wet ravines, No. 225, No. 480, No. 2106, No. 3916, No. 3976.

UMBELLIFERAE

Hydrocotyle mexicana Cham. & Schl.—At 1900 m. alt., in open wet ground, No. 439.

Spanantha paniculata Jacq.—At the foot of the mountain, in wet or swampy thickets, No. 946.

CORNACEAE

Cornus excelsa H.B.K.—At 1500 m. alt., in advanced forest, No. 4571.

CLETHRACEAE

Clethra glaberrima Lundell.—At 2000 m. alt., in wet advanced forest (type locality), No. 520, No. 3936.

Clethra parvifolia Lundell.—At 2300 m. alt., in advanced forest (type locality), No. 452.

Clethra quercifolia Lindl.—At 2000 m. alt., in open forest, No. 426, No. 448.

MONOTROPACEAE

Monotropa coccinea Zucc.—At 1500 m., in wet advanced forest, No. 1989.

ERICACEAE

Befaria laevis Benth.—At 1500-2000 m., in wet forest on the western slope, No. 430, No. 859, No. 1837.

Cavendishia crassifolia (Benth.) Hemsl.—In wet forest, at 2000 m., No. 858, No. 4227.

Gaultheria chiapensis Camp.—At 1700 m. or more, in wet advanced forest, No. 4156.

MYRSINACEAE

Ardisia compressa H.B.K.—In wet ravine and forest, at 1000 m., No. 3931.

Ardisia ovandensis Lundell.—At 1700 m., in wet advanced forest (type locality), No. 2549.

Ardisia rarescens Standl.—At 2100 m., in wet forest and ravines, No. 680, No. 3942, No. 4180.

Ardisia venosa Mast.—At 1900 m., in wet forest, No. 659.

Parathesis serrulata (Sw.) Mez.—At 1000 m., on the western slope, No. 1851.

Rapanea ferruginea (Ruiz & Pavon) Mez.—At 1500 m., in open forest, No. 677, No. 2004, No. 2213.

SAPOTACEAE

Achras zapote L.—At altitudes of 500-700 m., on the western slope, in open forest, No. 3254. Local name: "Chico Zapote."

Calocarpum sapota (Jacq.) Merrill.—In wet or dry forest at the foot of the mountain, No. 16673, Local name: "Zapote."

Chrysophyllum mexicanum var. *typicum* Cronq.—At the foot of the mountain, in wet

forest, No. 2621. Local name: "Caimito Simarron." Distributed as "C. olviforme L."

Dipholis Matudai (Lundell) Lundell.—At 900 m. alt., in wet forest (type locality), No. 571, 4175.

Sideroxylon calophylloides Lundell.—At 900-1200 m. alt., in moist forest (type locality), No. 4195.

SYMPLOCACEAE

Symplocos chiapensis Lundell.—At 1000- 1500 m. alt., in wet advanced forest (type locality), No. 2208.

STYRACACEAE

Styrax pilosus (Perk.) Standl.—At 1800 m. alt., in open forest, No. 4179.

Styrax polyneurus Perk.—At 1500 m. alt., in forest, No. 568, No. 2668, No. 3930.

LOGONIACEAE

Buddleia americana L.—At 1500 m. alt., in secondary growth, No. 964.

Buddleia floccosa Kunth.—At 1700 m. alt., on the western slope, in open thickets, No. 2258.

Buddleia ovandensis Lundell.—At 2000 m. alt., in wet ravine (type locality), No. 2664.

Buddleia Skutchii Morton.—At 1500 m., in open thickets, No. S-185. Previously distributed under the name "B. Matudai Standl."

Spigelia Humboldtiana Cham. & Schl..—At the foot of the mountain, in secondary growth and open fields, No. 2113.

APOCYNACEAE

Aspidosperma chiapensis Matuda.—At the foot of the mountain, in advanced forest (type locality), No. 2030. Local name: "Cliche." Distributed as "A. cruentum Woodson."

Mandevilla villosa (Miers) Woods.—At the foot of the mountain, in thickets, No. 1791.

Prestonia guatemalensis Woods.—At the foot of the mountain, in open thickets, No. 2159.

Prestonia mexicana A. DC.—At the foot of the mountain, in open thickets, No. 581, No. 2663.

Stemmadenia Donnell-Smithii Woods.—At the foot of the mountain, in secondary thickets, No. 415. Local name: "Chapona."

Stemmadenia Galeottiana (A. Rich.) Miers.—At 900 m. alt., in wet forest, No. 2096.

Tonduzia longifolia (A. DC.) Woods.—At 800 m. alt., in advanced wet forest, No. 4201.

ASCLEPIADACEAE

Blepharodon mucronatum (Schl.) Dcne.—At the foot of the mountain, in wet thickets, No. 1856.

Fischeria oaxacana Standl.—At the foot of the mountain, in open thickets, No. 644.

Funastrum clavsum (Jacq.) Schl.— At the foot of the mountain, in sandy thickets, No. 699.

Marsdenia macrophylla (H.B.K.) Fourn.—At the foot of the mountain, No. 498.

Matelea inops Woods.—At 1000 m. alt., in the edge of the forest, No. 4199.

CONVOLVULACEAE

Calonyction aculeatum (L.) House.—At the foot of the mountain, in wet thickets, No. 2135. Local name: "Gamusa."

Ipomoea polyanthes R. & S.—At the foot of the mountain, in sunny thickets, No. 1045.

Ipomoea triloba L.—At the foot of the mountain, in sandy thickets, No. 828.

Jacquemontia pentantha (Jacq.) Dcn.—At the foot of the mountain, in open thickets, No. 986.

Merremia quinquefolia (L.) Hallier.—At the foot of the mountain, in open thickets, No. 939.

Quamoclit coccinea (L.) Moench.—At the foot of the mountain, in sandy thickets, No. 847.

Quamoclit vitifolia (Cav.) Don.—At the foot of the mountain, in open thickets, No. 990.

POLEMONIACEAE

Cobaea pachysepala Standl.—At 1700 m. alt., in secondary growth, No. 447.

Loeselia ciliata L.—At the foot of the mountain, in sandy thickets, No. 2297.

Loeselia glandulosa (Cav.) Don.—At 1500 m. alt., in open thickets, No. 162.

HYDROPHYLLACEAE

Hydrolea spinosa L.—At the foot of the mountain, in swampy thickets, No. 2059.

Wigandia caracasana H.B.K.—From the foot of the mountain, up to 1500 m. alt., in sandy open growth, No. 1068. Local name: "Hoja de San Pablo."

BORRAGINACEAE

Cordia alliodora (R. & P.) Cham.—From the foot of the mountain, up to 800 m. alt., in open forest, No. 1086. Local name: "Laurel."

Cordia ambigua Schl.& Cham.—At 1000 m. alt., in open sandy ground, No. 771.

Cordia cana Mart. & Gal.—At 700 m. alt., in open thickets, No. 683.

Cordia ferruginea (Lam.) H.B.K.—At the foot of the mountain, in open thickets, No. 606.

Ehretia Luxiana Donn. Sm.—At 1000 m. alt., in open forest, No. 495.

VERBENACEAE

Aegiphila costaricensis Moldenke.—At 1000-1500 m. alt., in wet forest on the western slope (type locality) No. 572, No. 2101. Previously distributed as "Clerodendron Matudae Standl."

Aegiphila falcata Donn. Sm.—At the foot of the mountain, No. 666.

Aegiphila panamensis Moldenke.—At the foot of the mountain, in open thickets, No. 2115.

Aegiphila Skutchii Moldenke.—At 1800 m. alt., in secondary growth, No. 4190.

Citharexylum Mocini var. *longibracteolatum* Moldenke.—At 2000 m., in open forest, No. 2663, No. 3923.

Lantana camara var. *mista* (L.) L. H. Bailey.—From the foot of the mountain, to 500 m. alt., in open edge of forest, No. 2177. Local name: "Cinco negrito."

Lippia myriocephala Cham. & Schl.—At 1000 m. alt., in dry thickets, No. S-67.

Lippia pinetorum Moldenke.—In pineland, 1800 m. alt., (type locality) No. 3925. Distributed as "L. cardiostegia Benth."

Lippia substrigosa Turcz.—At 1800 m. alt., in open dry thickets, No. 122, No. 2068.

Petrea volubilis L.—In sandy open thickets, at the foot of the mountain, No. 1478.

Verbena litoralis H.B.K.—In sandy, sunny, open ground, from the foot of the mountain up to 1000 m. alt., No. 438.

Vitex Gaumeri Greenm.—At the foot of the mountain in open sandy thickets, No. 3905.

LABIATAE

Asterohyptis mociniana (Benth.) Epling.—In open pine woods, at 2000 m. alt., No. 2070.

Chaunostoma megistandrum Donn. Sm.—At 2300 m. alt., in limestone rock, open thickets, No. 427, No. 2649, No. 3915.

Cunila polyantha Benth.—At 1800 m. alt., in pine woods, No. 140.

Hyptis mutabilis (Rich.) Briq.—At the foot of the mountain, in open field, No. 2124.

Hyptis urticoides Kunth.—In open dry or moist thickets, from the foot of the mountain up to 1200 m. alt., No. 141, No. 181, No. 440.

Marsyptanthes chemaedrys (Vahl) Kuntze.—At the foot of the mountain, in wet open fields, No. 2145.

Salvia compacta Kuntze.—At 1900 m. alt., in open pine woods, No. 4009.

Salvia hyptoides Mart. & Gal.—At the foot of the mountain, in open wet thickets, No. 152, No. 2300.

Salvia lavanduloides Kunth.—At 2000 m. alt., in wet open ravine, No. 125.

Salvia purpurea Cav.—In open dry field, from the foot of the mountain up to 1000 m. alt., No. 156, No. 176.

Salvia rubiginosa Benth.—At the foot of the mountain, in wet thickets, No. 2127.

Salvia xalapensis Benth.—At the foot of the mountain, in open fields, No. 142.

SOLANACEAE

Cestrum lanatum Mart. & Gal.—At 1000 m. alt., in open thickets, No. 658.

Cestrum glanduliferum Francey.—At 1000 m. alt., in wet mixed forest, No. 657, No. 2586.

Capsicum stamoniifolium (H.B.K.) Kuntze.—At edge of the forest at 1800 m. alt., No. 2089.

Cestrum nocturnum L.—At the foot of the mountain, in moist thickets, No. 4722.

Juanulloa mexicana (Schl.) Miers.—At the foot of the mountain, up to 700 m. alt., parasite on trees, No. 492.

Physalis mollis Nutt.—In open field, at the foot of the mountain, No. 239.

Saracha procumbens (Cav.) R. & P.—At 1900 m. alt., in open fields and open thickets, No. 1833, No. 4191.

Solandra grandiflora Sw.—At 1900 m. alt., a woody vine, in advanced forest, No. 4222.

Solanum arrazolense Coult. & Donn. Sm.—At 1000 m., in wet thickets, No. 960.

Solanum brachystachys Dunal.—At 1000 m. alt., in forest, No. 432.

Solanum Donnell-Smithii Coult.—At the foot of the mountain, in open fields or sandy waste soil, No. 2624.

Solanum elaeagnifolium Cav.—At 2000 m. alt., in open secondary growth, No. 238.

Solanum Hartwegii Benth.—From the foot of the mountain up to 1000 m. alt., in open field, No. 243.

Solanum hispidum Pers.—At 500-1000 m. alt., in open thickets, No. 1567.

Solanum nigrum L.—From the foot of the mountain up to 1500 m. alt., in open thickets and in open fields, No. 1296. Local name: "Yerba Mora."

Solanum nudum H.B.K.—At 1200 m. alt., in open thickets, No. 252, No. 2269.

Solanum ovandensis Lundell.—A vine, at 1800 m. alt., in advanced forest (type locality), No. 4182.

Solanum verbascifolium L.—At the foot of the mountain, in sandy sunny soil, No. 245.

Solanum Wendlandi Hook.—At 1500-2000 m. alt., in open forest, No. 671. Local name: "Kishtan."

SCROPHULARIACEAE

Alonsoa meridionalis (L.f.) Kuntze.—At 1000-1900 m. alt., in open wet fields, No. 524.

Calceolaria mexicana Benth.—At 2000 m. alt., in open sunny fields, No. 2192.

Castilleja communis Benth.—At 1800-2300 m. alt., in open waste sandy ground, No. 143.

Castilleja glandulosa Greenm.—At 2000 m. alt., in open thickets, No. 168.

Hemichlaena fruticosa Benth.—At 1000-1500 m. alt., in open sunny thickets, No. 131.

Herpestis repens (Sw.) C. & S.—At the foot of the mountain, in wet open ground, No. 2158.

Lamourouxia cordata S. & C.—At 1900 m. alt., in sandy pine woods, No. 167.

Lamourouxia lanceolata Benth.—At 1000-2000 m. alt., in open sunny thickets, No. 2647.

Pentstemon barbatus Nutt.—In sandy open ground, at 1500 m. alt., No. 155.

Russelia chiapensis Lundell.—In open sunny thickets, at 1500-2000 m. alt., (type locality), No. 2088, No. 2563.

Sibthorpia pichinchensis H.B.K.—At 1900 m. alt., in wet grassy low ground, No. 2191.

Stemodia pedunculatis Benth.—At 1900 m. alt., in sandy sunny open thickets, No. 177, No. 2090.

BIGNONIACEAE

Arrabidaea floribunda (H.B.K.) Loes.—A woody vine, at the foot of the mountain, in the margin of the forest, No. 1565.

Enallagma sessilifolia (Donn. Sm.) Standl.—At 1800 m. alt., in wet forest, No. 1818, No. 4206. Local name: "Jicara de Mico."

Godmania aesculifolia (H.B.K.) Standl.—At the foot of the mountain in sandy thickets, No. 1798.

Tabebuia guayacan (Seem.) Hemsl.—From the foot of the mountain up to 600 m. alt., in open forest, without number. Local name: "Palo Blanco," "Primavera."

Tabebuia pentaphylla (L.) Hemsl.—From the foot of the mountain up to 500 m. alt., in sunny thickets and open fields, No. 1087. Local name: "Roble."

OROBANCHACEAE

Conopholis americana (L.) Wallr.—At 1200 m .alt., in moist forest, a parasite, No. 422, No. 2641.

GESNERIACEAE

Drymonia chiapensis Brandeg.—At 1500 m. alt., in advanced wet forest, on tree, No. 4225.

Kohleria elegans (Dcne) Loes.—In wet forest, at 1500 m., No. 962, No. 895, No. 3940, No. 1860.

Kohleria filisepala Standl.—At 1900 m. alt., in open moist thickets and mixed forest (type locality), No. 574.

Kohleria fruticosa Brandeg.—At 1200-1500 m. alt., in open thickets, No. 1828.

Nautilocalyx inclinatus (Brandeg.) Morton.—At the foot of the mountain, in wet soil of edge of forest, No. 628, No. 2601.

Solenophora purpusii Brandeg.—At 2000 m. alt., in wet ravine, No. 3957.

ACANTHACEAE

Aphelandra Schiedeana C. & S.—At 1500-2000 m. alt., in wet forest, No. 126, No. 3955.

Aphelandra deppeana Schlecht. & Cham.—At the foot of the mountain, in wet thickets, No. 151.

Barleria micans Nees.—At 1000 m. alt., in dense thickets and forest, No. 159.

Glockeria monolopha Donn. Sm.—At 1800 m. alt., in wet ravine, No. 3969.

Jacobinia aurea (Schl.) Hemsl.—At 1000 m. alt., in margins of the advanced forest, No. 161, No. 2074.

Jacobinia purpusii Brandeg.—At 1200-1700 m., in advanced open forest, No. 2577, No. 4209.

Justicia comata Lam.—At the foot of the mountain, along streamside, No. 558.

Justicia inaequalis Benth.—At 1500 m., in wet thickets, No. 3990.

Odontonema callistachyum (S. & C.) Kuntze.—At 1000 m., in moist thickets, No. 149.

Odontonema glabra Brandeg.—At the foot of the mountain in dry thickets, No. 170.

Ruellia Donnell-Smithii Leonard.—At 500 m. alt., in the margins of the forest, No. 123.

Ruellia metagalpae Linden.—At the foot of the mountain, in wet thickets, No. 158.

Ruellia megasphaera Lindau.—At 500m. alt., in wet open thickets, No. 124.

Sanchezia parvibracteata Spr. & Hut.—At the foot of the mountain, in open thickets, No. 128.

PLANTAGINACEAE

Plantago hirtella H.B.K.—At 1700 m. alt., in wet open ground, No. 4163.

RUBIACEAE

Anisomeria brachypoda (Donn. Sm.) Standl.—At 800 m. alt., in wet forest, No. 4174. New for Mexico; known previously from Guatemala.

Borreria latifolia (Aubl.) Schum.—At the foot of the mountain in secondary growth, No. 2142.

Borreria ocimoides (Burm.) C.—At the foot of the mountain, in wet thickets, No. 2149.

Bouvardia bouvardioides (Seem.) Standl.—At 1500-2000 m. alt., in wet woods, No. 2298.

Bauvardia dictyoneura Standl.—At 1900 m. alt., in pineland, No. 860, No. 2268, No. 2582, No. 4164.

Bouvardia Matudai Lundell.—At 1700 m. alt., in margins of advanced wet forest (type locality), No. 2667, No. 3964.

Bouvardia quinquenervata Standl.—At 2000 m. alt., in open sandy pine woods, No. 2069.

Calycophyllum candidissimum DC.—On sandy and stony ridges, from the foot of the mountain up to 500 m. alt., No. 491. Local name: "Madron."

Chiococca phaenostemon Schlecht.—At 1200 m. alt., in wet forest of western slope, No. 1822.

Coffea arabica L.—Cultivated, often escaped in open forest, at 500-1300 m. alt., without number. Also cultivated *Coffea maragogipe, Coffea bourbon* and *Coffea robusta.*

Coutarea hexandra (Jacq.) Schum.—On sandy bank of river, at the foot of the mountain, No. 2744.

Crusea calosephala DC.—At 2000 m. alt., in open wet ground, No. 2197.

Crusea coccinea DC.—At 1500-2000 m. alt., in open wet ground, No. 2574.

Deppea grandiflora Schlecht.—At 1000-2000 m. alt., in advanced wet forest, No. 500, No. 894, No. 1849.

Duggena panamensis (Cav.) Standl.—At the foot of the mountain, in wet thickets, No. 132. Distributed as *"Gonzalagunia panamensis."*

Faramea occidentalis (L.) Rich.—At 300-1000 m. alt., in dry or moist forest, No. 4176. Local name: "Hueso de Sapo."

Galium mexicanum H.B.K.—From 1500 m. up to 2300 m. alt., in wet open ground, No. 2196.

Genipa americana L.—At 1500-2000 m. alt., in advanced forest, No. 1566. Local name: "Manzanito."

Genipa vulcanicola Standl.—At 1800-2200 m. alt., in wet mixed forest, No. 433, No. 1633, No. 2081. New to Mexico; known previously from Guatemala.

Hamelia longipes Standl.—From 800 m. alt., down to the foot of the mountain, No. 574, No. 640, No. 4170. New for Mexico; known previously from Guatemala.

Hamelia patens Jacq.—From 900 m. alt., down to the foot of the mountain, in secondary growth, No. 653, No 4203.

Hoffmania angustifolia Standl.—At 1500 m alt., in deep forest, No. 1826, No. 3901, No. 4214. New for Mexico; known previously from Guatemala.

Hoffmania cryptoneura Standl.—At 1300 m. alt., or more, in wet forest (type locality), No. 944, No. 955, No. 4159.

Mitracarpus hirtus (L.) DC.—At the foot of the mountain, in open secondary growth, No. 2214.

Palicourea galeottiana Mart.—At 1000 m. alt., or more, in wet ravine, No. 1831.

Pinarophyllon flavum Brandg.—At 1000 m. alt., in open moist soil, No. 1763.

Plocaniophyllon flavum Brandeg.—At 1000 m. alt., in wet forest, No. 1836.

Fogonopus speciosus (Jacq.) Schum.—At the foot of the mountain, in open forest, No. 273, No. 560. New to Mexico; known previously from South and Central America.

Posoqueria latifolia (Lam.) R. & S.—At an altitude of 1500 m., in wet deep forest, No. 2552.

Psychotria chiapensis Standl.—At 700 m. alt., in wet forest, No. 4178.

Psychotria cuspidata Bredem.—At 700 m. alt., in open thickets, No. 665.

Psychotria horizontalis Sw.—At 900 m. alt., in wet open thickets, No. 528.

Psychotria involucrata Sw.—At 1000 m. alt., in mixed woods, No. 1819, No. 2542.

Psynhotria patens Sw.—At an altitude of 1000 m., in open forest, No. 682, No. 1419, No. 1820.

Randia aculeata L.—At an altitude of 900 m. alt., in advanced forest, No. 892.

Randia armata (Sw.) DC.—From the foot of the mountain up to 1000 m. alt., in dry open thickets, No. 516, No. 2631, No. 4161. Local name: "Crucecita."

Rudgea ceratopetala Donn. Sm.—At 800 m. alt., in mixed woods, No. 904, No. 3992.

Rondeletia buddleoides Benth.—At 1000-2000 m. alt., in wet forest, No. 570, No. 861, No. 3999, No. 4012.

Rondeletia intermedia Hemsl.—At 1800 m. alt., in moist open woods, No. 2086.

Rondeletia longiflora Benth.—At an altitude of 2000 m., in open forest, No. 1848.

Rondeletia suffrutescens Brandeg.—At 1800 m. alt., in wet ravine, No. 3998.

Rondeletia strigosa (Benth.) Hemsl.—At 1700 m. alt., under pine woods, No. 2566, No. 4152. Known previously from Guatemala, it seems to be new to Mexico.

CAPRIFOLIACEAE

Viburnum blandum Morton.—At 1900 m. alt., in wet or moist mixed woods, No. 431, No. 2662.

Viburnum guatemalense Gandog.—At 1000 m. alt., in open woods, No. 2556.

Viburnum Hartwegi Benth.—At an altitude of 1200-1500 m., in mixed forest, No. 425.

Viburnum montanum Lundell.—At 1700 m. alt., in mixed open forest, No. 2564, No. 3962.

VALERIANACEAE

Valeriana cacalioides Standl.—At an altitude of 2300 m., in limestone rock (type locality), No. 1812.

Valeriana cucurbitifolia Standl.—At 2300 m. alt., among exposed wet limestone rocks, No. 2572.

Valeriana scorpioides DC.—At 1900 m. alt., in open pine woods, No. 2187.

CUCURBITACEAE

Ahzolia composita (Donn. Sm.) Standl. & Steyerm.—At the foot of the mountain, in secondary thickets, No. 2151. Local name: "Huisquil de Caballo."

Cayaponia racemosa (Sw.) Cogn.—In thickets or at edge of thickets, at the foot of the mountain, No. 2172. Local name: "Mata Piojo."

Pittiera longipedunclata Cogn.—At the foot of the mountain, in open thickets, No. 2125.

Sicydium Schiedeanum Schl. & Cham.—At the foot of the mountain, in secondary thickets, No. 2628.

Sicydium tamnifolium (H.B.K.) Cogn.—At the foot of the mountain, in margins of forest, No. 519.

CAMPANULACEAE

Lobelia laxiflora H.B.K.—At an altitude of 1300 m. alt., in open thickets, No. 127.

Lobelia plebeia E. Wimmer.—At 2000 m. alt., in pine woods, No. 472.

COMPOSITAE

Ageratum rugosum Coult.—At 900 m. alt., in open fields, No. 717.

Ageratum tomentosum (Benth.) Hemsl.—At 1900 m. alt., in pine woods, No. 2548, No. 3968.

Archibaccharis flexilis Blake.—At 1000 m. alt., in dry or moist thickets, No. 711.

Archibaccharis hirtella var. *taeniotricha* Blake.—At 1000 m. alt., in dry secondary growth, No. 2639.

Archibaccharis sescenticeps Blake.—At an altitude of 1500 m., in open thickets, No. 706.

Archibaccharis Standleyi var. *aequivenia* Blake.—At 1500 m. alt., in secondary thickets, No. 700.

Baccharis glutinosa Pers.—At 1000 m. alt., in open thickets, No. 714, No. 725, No. 1026.

Bidens squarrosa H.B.K.—At 1200 m. alt., or more, in edge of thickets, No. 704, No. 3932.

Brickellia diffusa (Vahl) Gray.—At the foot of the mountain, in sandy open thickets, No. 788.

Coreopsis mutica DC.—At 1700 m. alt., in moist forest, No. 2595.

Chrysanthemum parthenium (L.) Bernh.—Mostly cultivated, often escaped, at 1900 m. alt., No. 776. Local name: "Altamisa."

Dahlia excelsa Benth.—At 2000 m. alt., in wet thickets, No. 2233.

Erigeron bonariensis L.—At 1700 m. alt., in sunny waste ground, No. 760.

Erigeron Karwiniskianus DC.—At 2300 m. alt., among moist rocks, No. 760.

Eupatriastrum Nelsonii var. *cardiophyllum* Robins. & Greenm.—From the foot of the mountain up to 700 m. alt., in sandy open thickets, No. 2134.

Eupatriastrum opadoclinium Blake.—At 1700 m. alt. in pine woods (type locality), No. 702.

Eupatorium angulifolium Robins.—At 1700 m. alt., in sandy open thickets, No. 726.

Eupatorium areolate Sc.—At an altitude of 1500 m., in open pine woods, No. 1546.

Eupatorium Heydeanum Robins.—At 1000 m. alt., in edge of forest, No. 2656.

Eupatorium hospitale Robins.—At an altitude of 1200 m., in open thickets, No. 1028.

Eupatorium leucocephalum Benth.—At 2000 m. alt., in open woods, No. 2652.

Eupatorium macrophyllum L.—At the foot of the mountain, in open thickets, No. 724.

Eupatorium odoratum L.—At 1000 m. alt., or more, in open woods, No. 777.

Eupatorium Pittieri Klatt.—At 1000 m. alt., in open woods, No. 701, No. 4010.

Eupatorium pycnocephalum Less.—At 700 m. alt., or less, in open woods, No. 862.

Eupatorium quadrangulare DC.—At the foot of the mountains, in open secondary growth, No. 781.

Eupatorium Schultzii Sch. B. P.—At 1900 m. alt., in open wet woods, No. 727, No. 774.

Gnaphalium leptophyllum DC.—In sunny open pine woods, at 1900 m. alt., No. 784.

Gnaphalium oxyphyllum var. *semilanatum* DC.—At an altitude of 1900 m., in open thickets, No. 703.

Gnaphalium semiamplexicaule DC.—At 2000 m. alt., in open thickets, No. 3952.

Gomphrena Palmeri Standl.—At the foot of the mountain, along sandy banks of rivers, No. 2160.

Hemibaccharis Standleyi var. *aequivenia* Blake.—At 1900 m. alt., in secondary open growth, No. 4005.

Hymenostephium cordatum (H. & A.) Blake.—At an altitude of 1700 m., in open thickets, No. 708, No. 3958.

Mikania cordifolia (L. f.) Willd.—At 1500 m. alt., in edge of forest, No. 1017.

Mikania globosa Coult.—A woody vine, at 1900 m. alt., in wet woods, No. 4149.

Mikania micrantha H.B.K.—At 1000 m. alt., in sunny thickets, No. 759.

Montanoa frutescens (Mairet.) Hemsl.—At 2000 m. alt., in open thickets, No. 2235.

Montanoa hibiscifolia (Benth.) Schutz.—At the foot of the mountain, in open thickets, No. 723. Nocal name: "Bala blanca."

Neurolaena lobata (L.) R. Br.—In open secondary growth from the foot of the mountain up to 700 m. alt., No. 1850, No. 2605.

Perymenium discolor Schrad.—At 1500-2000 m. alt., in open fields, No. 783.

Rensonia salvadorica Blake.—At the foot of the mountain, in open fields, No. 719.

Rumfordia media Blake.—At an altitude of 1000 m., in open thickets (type locality), No. 710.

Schistocarpha Kellermanii Rydb.—At an altitude of 1900 m., in open thickets, No. 709.

Senecio cobanensis Coult.—At an altitude of 1900 m., in pine woods, N. 713.

Senecio cristobalensis Greenm.—At 1900 m. alt., in open pine woods, No. 2103.

Senecio Kermesinus Hemsl.—At 1500 m. alt., in open secondary thickets, No. 729.

Senecio uspantanensis (Cout.) Greenm.—At 1900 m. alt., in open pine woods, No. 3926.

Spilanthes ocymifolia (Lam.) A. H. Moore.—At an altitude of 1000 m., in secondary growth, No. 728.

Stevia rhombifolia H.B.K.—At 1900 m. alt., in open edge of forest, No. 773, No. 1021.

Synedrella nodiflora (L.) Gaertn.—At the foot of the mountain, in open thickets, No. 557.

Tagetes foetidissima DC.—At 2000 m. alt., in secondary thickets, No. 4002.

Tagetes jaliscensis Greenm.—At the foot of the mountain, in sandy waste soil, No. 2120.

Tithonia diversifolia (Hemsl.) A. Gray.—At the foot of the mountain, in open secondary thickets, No. 789.

Verbesina crocea (Cav.) Less.—At 1000-2000 m. alt., in open thickets, No. 716, No. 3949.

Verbesina punctata Robins. & Greenm.—At 900 m. alt., in secondary growth, No. 718.

Verbesina turbacensis H.B.K.—At 1900 m. alt., in secondary thickets, No. 436.

Vernonia deppeana Less.—At an altitude of 1000 m., in open secondary fields, No. 705.

Vernonia patens H.B.K.—At the foot of the mountain, in secondary fields, No. 1081. Local name: "Suquinay."

Vernonia polypleura Blake.—At an altitude of 1000 m., in secondary growth (type locality), No. 730.

Vernonia tortuosa (L.) Blake.—At the foot of the mountain, in open thickets, No. 736, No. 2031.

Vernonia trifloscolosa H.B.K.—At an altitude of 1300 m., in open fields, No. 1561.

Zexemnia frutescens (Mill.) Bilake.—At 800 m. alt., in secondary growth, No. 709, No. 4200.

GRAMINEAE

Agropyron cenchroides Humb. & Bonpl.—At 2300 m. alt., in open edge of woods, No. 2557.

Arundinella deppeana Nees.—At the foot of the mountain, in open fields or in secondary thickets, No. 2033.

Bouteloua hirticulmis Scribn.—At the foot of the mountain, in open fields, No. 342.

Chusquea sulcata Swallen.—At 1500-2300 m. alt., in open forest, No. 321.

Digitaria sanguinalis (L.) Scop.—At the foot of the mountain, in open fields, No. 338.

Eragrostis limbata Fourn.—At the foot of the mountain, in open fields, along roadsides, No. 346.

Eragrostis maypurensis (H.B.K.) Steud.—At the foot of the mountain, in open fields and sandy ground, No. 2131. Local name: "Pan Caliente."

Hackekochloa granularis (L.) Kuntze.—At the foot of the mountain, in open wet ground, No. 1794.

Lasiacis ruscifolia (H.B.K.) Hitchc.—At the foot of the mountain, in moist fields, No. 2117.

Muehlenbergia Emersleyi Vasey.—From the foot of the mountain up to 900 m., in open fields, No. 309, No. 322.

Olyra latifolia Desv.—At the foot of the mountain, in secondary thickets, No. 341.

Oryza latifolia Desv.—At the foot of the mountain, in wet open thickets, No. 1802.

Oplismenus Burmannii (Retz.) Beauv.—At the foot of the mountain, in edge of thickets, No. 2130.

Panicum cayennense Lam.—At the foot of the mountain, in wet open thickets, No. 1799.

Panicum fasciculatum Sw.—At the foot of the mountain, in sandy bush, No. 336.

Panicum frondescens Meyer.—At the foot of the mountain, in thickets, No. 332.

Paspalum candidum H.B.K.—At the foot of the mountain, in wet bush, No. 318.

Poa annua L.—At the foot of the mountain, in wet open field, No. 312.

Setaria paniculifera (Steud.) Fourn.—At the foot of the mountain, in open thickets, No. 347.

Sporobolus Poiretii (Roem. & Schult.) Hitchc.—At the foot of the mountain, in moist fields, No. 335.

Tricholaena rosea Nees.—At the foot of the mountain, in moist fields, No. 333.

Trisetum irazuense (Kuntze) Hitchc.—At the foot of the mountain, in open bush, No. 345.

CYPERACEAE

Carex polystachya Sw.—At an altitude of 1500-2000 m., in open forest, No. 2565, No. 4162.

Cyperus densicaespitosus Mattf. & Kukenth.—At the foot of the mountain, in open wet ground, No. 297.

Cyperus diffusus var. *tolucensis* (H.B.K.) Kukenth.—At the foot of the mountain, in open moist fields, No. 301, No. 306.

Cyperus diffusus subsp. *chataranthus* (Presl) Kukenth.—At 1900 m. alt., in pine woods, No. 2553.

Cyperus hermaphroditus (Jacq.) Standl.—At 1500 m., in open wet bush, No. 2566.

Cyperus ligularis L.—At the foot of the mountain, in wet open bush, No. 304.

Cyperus regiomontanus Britton.—At the foot of the mountain, in wet field, No. 303.

Cyperus simplex H.B.K.—At the foot of the mountain, in wet field, No. 305.

Cyperus surinamensis Rottb.—At the foot of the mountain, in wet field, No. 298.

Fimbristylis diphylla (Retz.) Vahl.—At the foot of the mountain, in open field, No. 309.

ARACEAE

Anthurium aemmulum Schott.—At the foot of the mountain, in wet forest, on trees, No. 980.

Anthurium chiapensis Standl.—At 2000 m. alt., in wet forest (type locality), No. 1562.

Anthurium scandes (Aubl.) Engler.—At 1900 m. alt., in wet forest, on trees, No. 4205.

BROMELIACEAE

Catopsis triticea L. B. Smith.—At 1800 m. alt., in wet forest, on trees (type locality), No. 2570.

Pitcairnia dinsiflora Brongn.—At 1000-2000 m. alt., in wet forest, among rocks, No. 1854.

Pitcairnia heterophylla (Lindl.) Beer.—At 2000 m. alt., in forest, on trees, No. 382.

Pitcairnia saxicola L. B. Smith.—At 2300 m. alt., among sunny rocks, No. 4226.

Tillandsia Butzii Mez.—At 2000 m. alt., in forest, on trees, No. 2657.

Tillandsia excelsa Griseb.—At an altitude of 1900 m., on trees, in wet forest, No. 2071.

Tillandsia fasciculata Sw.—At 2300 m. alt., in wet forest, on trees, No. 1845, No. 3974.

Tillandsia filifolia Ch. & Schl.—At 2000 m. alt., in wet forest, on trees, No. 2642.

Tillandsia usneoides L.—At 2000 m. alt., in open forest, on trees, No. 2343.

COMMELINACEAE

Athyrocarpus leiocarpus (Benth.) B. & H.—At the foot of the mountain, in edge of forest, No. 2155.

Callisia monandra (Sw.) Schult.—At 1000 m. alt., in wet edge of forest, No. 9965.

Callisia multiflora (Mart. & Gal.) Standl.—From the foot of the mountain, up to 1500 m. alt., in open forest, No. 2095.

Callisia repens L.—At the foot of the mountain, in wet fields, No. 976, No. 2111.

Campelia zanonia (L.) H.B.K.—At 2000 m. alt., in wet ravine, No. 3970.

Commelina elegans H.B.K.—At 500 m. alt., in wet forest, No. 4015.

Leplorrhoeo filiformes (Mart. & Gal.) C. B. Clarke.—At the foot of the mountain, in wet fields, No. 2167.

Tinantia leiocalyx C. B. Clarke.—At the foot of the mountain, in edge of the forest, No. 2110.

Tradescantia commelinoides R. & S.—At the foot of the mountain, in the edge of wet forest, No. 1050, No. 2242.

Tradescantia cumanensis Kunth.—At the foot of the mountain, in edge of wet forest, No. 940, No. 2176.

Tradescantia plusiantha Standl.—At an altitude of 2000 m., in edge of open forest (type locality), No. 2569.

LILIACEAE

Smilacina flexuosa Bertol.—At an altitude of 1500-2000 m., in open wet forest, No. 374.

Smilacina paniculata M. & G.—At 1500 m. alt., in open forest, No. 359, No. 1825.

Smilax aristolochiaefolia Mill.—At an altitude of 1000 m., in thickets and woods, No. 352, No. 2092.

Smilax lanceolata L.—At 1500 m. alt., in advanced forest, No. 3988.

Smilax mollis H. & B.—At 1000 m. alt., in bush, No. 4195.

Smilax velutina Killip & Morton.—At 700-1500 m. alt., in open forest and in thickets, No. 351, No. 356.

HAEMODORACEAE

Xiphidium coeruleum Aubl.—At the foot of the mountain, in wet thickets, among rocks, No. 2597.

AMARYLLIDACEAE

Bomarea edulis (Tussac.) Herb.—At the foot of the mountain, in dry thickets, No. 1797.

DIOSCOREACEAE

Dioscorea convolvulacea Schl. & Cham.—At the foot of the mountain, in open thickets, No. 2126.

Dioscorea convolvulacea var. *glabra* Uliine.—At the foot of the mountain, in open fields, No. 832, No. 985.

Dioscorea densiflora Hemsl.—At the foot of the mountain, up to 500 m. alt., in open thickets, No. 1018.

Dioscorea floribunda Mart. & Gal.—From the foot of the mountain up to 88 m. alt, in thickets, No. 831, No. 974, No. 2143.

Dioscorea polygonoides H. & B.—From the foot of the mountain to 800 m. alt., in open thickets, No. 989, No. 2245.

Dioscorea spiculiflora Hamsl.—From the foot of the mountain up to 1000 m. alt., in open thickets, No. 875, No. 1817.

ZINGIBERACEAE

Hedychium gardonerianum Rose.—At 1000-1500 m. alt., in wet ravine, No. 945.

Renealmia aromatica (Aubl.) Griseb.—At altitude of 1000 m., in wet forest, No. 1844.

MARANTACEAE

Calathea micans Koern.—At 1300 m. alt., in wet forest, No. 1568.

Pleistachya pruinosa (Regel) Schum.—At the foot of the mountain, in open forest, No. 2610. Local name: "Lengua de vaca."

ORCHIDACEAE

Arpophyllum alpinum Lindl.—At 1900-2300 m. alt., in advanced forest, on trees, No. 367.

Brassavola nodosa (L.) Lindl.—At 300-500 m. alt., in forest, on trees, No. 1793.

Brassia verrucosa Batem.—At 1700 m. alt., in forest, on trees, No. 1830.

Bulbophyllum pachyrrhachis (A. Rich.) Griseb.—At the foot of the mountain, in forest, on trees, No. 2055.

Campylocentrum micranthum (Lindl) Rolfe.—At the foot of the mountain, in forest, on trees, No. 2743.

Catasetum sp.—At the foot of the mountain, in open field, on trees, No. 3880.

Cattleya Skinneri Baten.—At the foot of the mountain, in forest on trees, No. 364.

Chysis laevis Lindl.—At 1000 m. alt. in advanced forest, on trees, No. 2085.

Cranichus ciliata Kunth.—At 1700 m. alt., in virgin wet forest on earth, No. 4189.

Cranichus Wageneri Rochb. f.—At 1900 m. alt., in wet forest, on earth, No. 1807.

Cyrtopodium punctatum Lindl.—From the foot of the mountain up to 700 m. alt., in sandy thickets, on earth, No. 2179.

Dichaea graminoides (Sw.) Lindl.—At 1900 m. alt., in wet forest, on trees, No. 4181.

Dichaea muricata (Sw.) Lindl.—At 1000-2000m. alt., in wet forest, on trees, No. 362.

Dichaea neglecta Schltr. At 1500-2000 m., alt., in wet forest, on trees, No. 1811.

Elleanthus capitatus (R. Br.) Reichenb f.—At 1000-2300 m. alt., in advanced forest, on trees, No. 2587, No. 4207.

Epidendrum brassavola Reichenb. f.—At 2300 m. alt., among sunny rocks, No. 257.

Epidendrum ciliare L.—At 1500 m. alt., in forest, on trees, No. 2054.

Epidendrum chinensis (Lindl.) Ames.—At the foot of the mountain, in woods, on trees, No. 361.

Epidendrum ioniophlebium Reichenb. f.—At the foot of the mountain, in woods, on trees, No. 1013.

Epidendrum myrianthum Lindl.—At 2000m. alt., among open rocks, No. 2538.

Epidendrum ochraceum Lindl.—At 1000 m. alt., in forest, on trees, No. 378, No. 1810.

Epidendrum pentotis Reichenb. f.—At 1000 m. alt., in wet forest, on trees, No. 1858.

Epidendrum radicans Pav. ex Lindl.—At 1000 m. alt., among open dry rocks, No. 379.

Epidendrum ramosum var. *mextum* (Schtr.) A. H. & S.—At 1900 m. alt., in pine woods, No. 2555.

Epidendrum stamfordianum Batem.—At the foot of the mountain, in forest, on trees, No. 2057.

Epidendrum verrucosum Sw.—At 2300 m. alt., among open, dry rocks, No. 2539.

Gongora galeata (Lindl.) Reichenb. f.—At 2000 m. alt., in wet forest, on trees, No. 2550.

Goodyera dolabripetala (Ames) Schltr.—At 1900 m. alt., in wet forest, on earth, No. 1806.

Habenaria flexuosa Lindl.—At the foot of the mountain, in forest, on earth, No. 376.
Isochilus linearis (Jacq.) R. Br.—At 1900 m. alt., in forest, on trees, No. 813.
Lycaste aromatica L.—At 1000-2000 m. alt., in open forest, on trees, without number.
Malaxis calycina (Lindl.) Kuntze.—At 1900 m. alt., in pine land, on earth, No. 373.
Malaxis excavata Lindl.—At 1800 m. alt., in advanced forest, on earth, No. 4218.
Malaxis unifolia Michx.—At 1600 m. alt., in pine woods, on earth, No. 4217.
Maxillaria cucullata Lindl.—At 1000-2000 m. alt., in forest, on trees, No. 380.
Maxillaria Hontteana Reichenb. f.—At 1500 m. alt., in woods, on trees, No. 2056.
Maxillaria variavilis Batem.—At 2000 m. alt., in wet forest, on trees, No. 2072.
Mormodes histris Lindl. & Reichenb.—At 1250 m. alt., in open woods, on trees, No. 2578.
Odontoglossum laeve Lindl.—At 1900 m. alt., in wet forest, on trees, No. 2183.
Odontoglossum oligautum Reichenb. f.—At 2000 m. alt., in wet forest, on trees, No. 3973.
Oncidium cavendishianum Batem.—At 2000 m. alt., in forest, on trees, No. 3918.
Oncidium oblongatum Lindl..—At the foot of the mountain, in open forest, on trees, No. 1869.
Oncidium ornithorhynchum H.B.K.—At 1900 m. alt., in forest, on trees, No. 4019.
Ornithidium densum Reichenb. f.—At 1900 m. alt., in wet forest, on trees, No. 1805.
Physosiphon tubatus Reichenb. f.—At 2000 m. alt., in wet forest, on trees, No. 2551.
Pleurothallis marginata Lindl.—At the foot of the mountain, in forest, on trees, No. 2626.
Pleurothallis Matudiana C. Schweinf.—At 2300 m. alt., in wet forest, on trees (type locality), No. 2559, No. 3991.
Pleurothallis ophiocephala Lindl.—At 1900 m. alt., in forest, on trees, No. 2083.
Sarcoglottis hemichorea (Lindl.) Ames.—At 500 m. alt., among open sunny rocks, No. 1085.
Sobralia macrantha Lindl.—At 1500 m. alt., among open dry rocks, No. 5338.
Spiranthes elata (Sw.)L. C. Rich.—At 2000 m. alt., in forest, on earth, No. 2084.
Spiranthes violaceae A. Rich. & Gal.—At 1900 m. alt., in pine woods, on earth, No. 2098.
Stelis purpurasecns A. Rich. & Gal.—At 2000 m. alt., in forest, on trees, No. 3972.
Stelis tenuissima Schltr.—At 2000 m. alt., in forest, on trees, No. 2588.
Trichopia tortilis Lindl.—At 1000 m. alt., in wet forest, on trees, No. 1815.
Trigonidium Egertonianum Batem.—At the foot of the mountain, in forest, on trees, No. 2112.
Triphora mexicana (S. Wats.),—At 700 m. alt., in wet forest, on earth, No. 2541.
Vanilla fragans (Salisb.) Ames.—At the foot of the mountain, in wet forest, on trees, without number.

A Review of Salix anglorum and Salix petrophila

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In preparing treatments of portions of the genus *Salix* for certain manuals, extreme brevity is essential. Discussion of previous mistreatments, statement of reasons for conclusions, and citation of reassigned specimens all are impossible. Likewise, the descriptions are too limited to make students acquainted with novelties, either previously or currently published. The writer has been guilty twice of such unfair taxonomic practices. The present paper attempts to clear up the misunderstandings of one widely distributed arctic-alpine group.

The Mixup of Salix arctica Pallas and S. arctica R. Brown

Salix anglorum Chamisso, in one or another of its forms, is one of the most widely distributed and most frequently collected of American arctic and alpine willows. It has been so messed up, so successively, by so many botanists, however, that great confusion exists and frequently it is not recognized when collected. Briefly, *Salix arctica* Pallas (Fl. Rossica 1(2): 86) was published in 1788. What happened in the next 130 years was fully discussed by Schneider (l,c., below) in 1918.

The trouble began when Robert Brown published a second and different *S. arctica* in 1819 as a *nomen nudum* and described it in 1823. Chamisso attempted to correct this error by publishing a new name for Brown's *S. arctica* in 1831. He merely said: "*Salix anglorum* N.—*S. arctica* R. Brown . . ." and cited two Bering Sea specimens which belonged, however, to an entirely different species. Unfortunately, this citation threw botanists off the track and his *S. anglorum* was considered a synonym of *S. phlebophylla* instead of a valid new name for *S. arctica* R. Brown. Only part of the numerous publications and discussions are listed below. Others will be found under the three Schneider varieties presented farther on.

Salix anglorum Chamisso, in Linnaea 6: 541. 1831 (except for specimens cited; Schneider, Bot. Gaz. 66: 126-127. Oct. 1918; Johansen, Rept. Canad. Arctic Exped., 1913-18. Vol. 5 (Botany),—Pt. 5A: 10, 1921;—Pt. 5B: 18-19, 1922;—Pt. 5C: 36-37, pl. 7, fig. 2 ,1924; Ulke (Titus), (A Flora of Yoho Park, British Columbia)), Catholic Univ. of America, Biol. Lab. Bull. 14: 64. 1934.

Salix arctica Robert Brown, in Ross, Voyage Explor. Baffin's Bay, App. p. 143, 1819, and Ed. 2, 2: 194, 1819 (nomen nudum, non Pallas); Chloris Melvilliana 24 (desc.), 1823; Capt. Parry's Voyage, App., Suppl. p. 282, 1824. Richardson, in Franklin, Narr. Journey Polar Sea 752 (reprint p. 24), 1823; Ed. 2, p. 765 (reprint p. 37), 1823. Macoun, Cat. Canad. Pl. 1(3): 444-445, 1886.

Salix arctica Pallas (in the broad sense, including *S. anglorum* Chamisso), Polunin, (Bot. Canad. East. Arctic), Natl. Mus. Canad. Bull. 92: 157. 1940.

Salix arctica Pallas, var. *Brownei* Andersson, in DC. Prod. 16(2): 286. 1868 (in part).

Salix Brownei (Andersson) Lundstrom, in Nov. Act. Reg. Soc. Sci. Upsala III (1877): 37 (for the most part).

Salix Brownii Bebb, in Bot. Gaz. 14: 115, 1889 (for the most part); Macoun, Cat. Canad. Pl. 2(5): 356. 1890 (in part).

Salix fullertonensis x *S. groenlandica* Schneider, in Bot. Gaz. 66: 342-343, Oct., 1918 (for the most part).

Salix hudsonensis Schneider, in Bot. Gaz. 67: 57-58, Jan., 1919 (partly var. *antiplasta*); Polunin (Bot. Canad. East. Arctic), Natl. Mus. Can. Bull. 92: 161. 1940.

Schneider has given a detailed discussion of the materials studied and the conclusions reached by the other authors cited above, and of the errors of interpretation they made. In 1899, the writer discussed Andersson's *S. arctica* var. *petraea* and made the statement below (Trans. Acad. Sci. St. Louis 9: 89-90). It is obvious, from the concluding sentence, that he did not then know of the publication of the name *S. anglorum* Chamisso.

> The methods by which Prof. Andersson succeeded in greatly augmenting the then existing confusion in regard to *S. arctica* R. Br. and *S. arctica* Pallas have been exposed by Mr. Bebb (Bot. Gaz. 14: 115-117, 1889). The vigor and conciseness of his language render the accusation almost dramatic. But great as was the service he rendered, and good as his intentions undoubtedly were, it seems that he only added to the burden of synonymy when he renamed "Mr. Brown's *S. arctica*." His name was an evident homonym, for, while *S. Brownii* Bebb was published in 1889, *S. Brownei* (Anderss.) Lundstr. had been published in 1877. . . . Mr. Bebb was fully aware of this variety, even if ignorant of its elevation to specific rank, when he named his *S. Brownii*. We can attribute his action only to a strong desire to compensate the wrong done by Andersson to the labor and memory of Robert Brown. But in thus using a name which he knew to be occupied, he deliberately laid himself open to the very charge on which he had just scored Andersson so severely, and left the nomenclature of the species in worse shape than he found it. I shall not rename the plant now, for I believe the name which has been in use for eighty years (*S. arctica* R. Br.) can yet do duty until both the numerous variations and the synonymy have been given careful study.

Almost simultaneously with the paper just quoted, Rydberg discussed Chamisso's species (Bull. N. Y. Bot. Gard. 1: 266. 1899) and wrote:

> There is scarcely a species that has been so misunderstood as this. Even Mr. Bebb, who cleared up somewhat the discrepancy between *S. arctica* Pallas and *S. arctica* R. Br., had a very vague idea about the latter, for he included under the name *S. Brownii* a number of quite distinct forms. The more or less fruticose species named *S. arctica* or *S. Brownii* from the Rocky Mountains, Canada, Newfoundland, and Labrador do not belong here. *S. anglorum* is an arctic species and takes the place of *S. arctica* in the East.

Even if his strictures of Bebb had been true, Rydberg did not improve the situation because the plants he assigned to *S. anglorum* really represented *S. arctophila* Ckll. (*S. groenlandica* (Anderss.) Lundstrom). He then inserted *S. groenlandica* and assigned to it a lot of specimens belonging to *S. cordifolia*. He then published his *S. petrophila*, recognizing it as closely related to *S. anglorum*, but separating it therefrom by assigning to it some characters (especially leaves green beneath) which it does not possess.

Recently, some American botanists have united *S. arctica* Pallas and *S. anglorum* Chamisso as a single species, under the older name, after keeping them as distinct species for 125 years. Curiously enough, some of those who are doing this are themselves making new species and varieties on the slightest of excuses.

1. SALIX ANGLORUM CHAMISSO

Salix arctica R. Brown was described by Richardson as having leaves elliptic-obovate and entire and finally glabrous, glaucous beneath; capsules elongated, sessile, gray-tomentose, with graceful styles; and scales obovate-rotund, blackish, and sericeous. Chamisso did not describe his *S. anglorum* but merely substituted that name for *S. arctica* R. Br., not Pallas.

In 1918, Dr. Camillo Schneider published the first paper in his series entitled *North American Willows*. It dealt with "The Species Related to *S. arctica Pall.*" Therein he discussed *Salix anglorum* (4.5 pages), described three new varieties of it (5 pages), maintained *S. petrophila* Rydberg, and reduced *S. caespitosa* Kennedy, to the status of a variety under *S. petrophila*. His discussion of the species and of all his new varieties is filled with expressions of uncertainity as to the limits of variation in the different entities, and of doubt as to the identity and relationships of many of the specimens which he cites. These doubts were recorded also on his annotation labels.

Schneider gave (p. 127) only an 11-line Latin description of *S. anglorum*, with his 4.5-page discussion. He refers (p. 129) to "the ample material before me" but he certainly did not give an ample description of this species, so long and so widely misunderstood. No measurement is given for any organ except the staminate ament: "8-10 lin. longa." In general, his description is accurate, but without leaf sizes given it would include some of the varietal material, especially var. *araioclada*. A fuller description is given herewith.

In his second paper on American willows, Schneider published a supposed hybrid (Bot. Gaz. 66: 342. 1918) from the west coast of Hudson Bay. He recorded, doubtfully: "The following specimens look to me more or less like forms that might be taken for *S. fullertonensis* x *S. groenlandica.*" *S. fullertonensis* is a trailing species related to the erect *S. brachycarpa* of Section Glaucae. *S. groenlandica* is a former name for *S. arctophila* Ckll. of Section Ovalifoliae and closely related to *S. anglorum*. Three months later, in his third paper, Schneider redescribed this "hybrid" as a supposed new species, *S. hudsonensis* (Bot. Gaz. 67: 57, Jan., 1919), and correctly assigned it to Section Ovalifoliae. He says (p. 58) that it is:

> . . . closely related to *S. arctophila*, from which it chiefly differs in the shorter pedicels and the more elongated gland. Judging by the flowers alone, one might be inclined to take it for a form of *S. anglorum* but the leaves are mostly without any traces of stomata in the upper epidermis and their color and texture are more like in *S. arctophila*.

An examination of most of the material cited by Schneider in these two papers shows that the supposed hybrid of 1918 was based on specimens of *S. anglorum*, but that the type of *S. hudsonensis* belongs to *S. anglorum* var. *antiplasta* Schneider (Ball, Canad. Field-Nat. 62: 151-152. 1948.), which he does not even mention. These doubts, duplications, and overlappings show quite clearly that Schneider never developed a clear concept of *S. anglorum* and could not readily recognize or separate his varieties of it.

In evaluating Schneider's work, we must remember the conditions under which it was done. He arrived here on a visit from Germany just before we entered World War I. Interned as a German national, he was paroled to the

Arnold Arboretum, and assigned by Dr. Sargent to prepare a revision of American Salices. Unfamiliar with our willows, he could not visit herbariums, but was required to publish rapidly, with novelties in each issue. A prisoner far from home, paid but little, worried about the support of his family in Germany, and working under the unfavorable conditions named, it is not surprising that he made frequent expression of doubt and uncertainty or published unwarranted novelties. The wonder is that he did so well.

For the following evaluation of *S. anglorum* and its varieties, the centripetal method (Journ. Arnold Arb. 27: 377-378) for studying ample herbarium material was used. In brief, some 300 specimens of the four named entities were removed from their herbarium covers and arranged in one series by geographic units (States, Provinces, etc.). This material then was studied sheet by sheet, to determine if each specimen showed the basic characters of the species. A few which differed from the accepted characters of the Section Ovalifoliae or of the species *anglorum* were set aside. (A later restudy of this material revealed several hybrids, two specimens of *S. arctophila*, and one specimen of Section Glaucae).

The original mass, without these few, then was separated into groups by obvious differences in vegetative characters, especially in the shape and size of the different leaf types found on each twig and by comparison of twigs of early and later growth. Comparison also was made of relative length, stoutness, and hairiness of branchlets. Then each group thus based on vegetative characters was studied to determine any correlations or differences in floral characters. All of this was done without reference to the original labels or to any determinations previously made. The same methods were used with the material in the U. S. National Herbarium.

After this grouping, all specimens in each group were restudied to determine if the range of variation in each specimen had been accurately grasped and if the characters of juvenile specimens had been correctly interpreted. This restudy shifted a few specimens. Often it is impossible to be sure of the future appearance of a juvenile specimen. Anyone who has tried to match correctly the childhood photographs of individuals with those taken in middle life will appreciate this problem in the willows. An expanded description of the species follows.

Prostrate, with stoutish more or less subterranean branches and more or less elongated (to 20 cm.) creeping or running branchlets, the younger yellowish to purplish, sometimes pruinose, and often more or less pubescent to glabrate, the older purplish to blackish and glabrous; buds ovate, 4-8 mm. long, sometimes pruinose, the younger sometimes thinly pubescent; stipules none (or rarely few, 2-5 mm. long, linear-lanceolate, denticulate); petioles 3-10 or 12 mm. long; blades chartaceous, elliptical-oval to narrowly or broadly obovate, 2.5-5 or 6 cm. long, 1-2.5 or 3.5 cm. wide, mostly rounded at apex or the apical acutish and sometimes plicate, acute to rounded at base, entire (or rarely with a few denticulations), bright green and glabrous above and glaucescent to glaucous with raised and reticulated veins beneath at maturity, the very young sometimes more or less pubescent above and often long-pilose beneath, sometimes remaining ciliate at maturity.

Aments coetaneous or rarely somewhat serotinous, 2-5 or rarely 6-7 cm. long, 1.3-1.8 cm. wide, rather densely flowered, on leafy and more or less hairy peduncles 1-3 or 4 cm. long; scales narrowly to broadly obovate, mostly rounded or rarely subretuse at apex, occasionally acutish, dark brown to blackish, 1.5-2.5 mm. long, more or less long-villous, sometimes becoming glabrate outside; stamens two, filaments free, glabrous; ovaries ovate, white tomentose, capsules ovate-conic or lanceolate, 5-7 or 8 mm. long, sessile or very short-pedicelled, densely gray-pubescent; styles slender, 0.7-1.2 or 1.5 mm. long, often more or less divided above; stigmas 0.4-0.7 mm. long, more or less divided; glands mostly slender, capitate, 1 or sometimes 2 in staminate flowers, 1 in pistillate.

S. anglorum is a species of arctic and alpine America. In the East, its known range is from 52° N on the Labrador coast, and 54° and 55° N on the east and west coasts, respectively, of Hudson Bay, north to at least 78° N in Greenland and thence westward on the mainland and the islands of the Arctic Ocean. In the West, it occurs from Glacier Natl. Park in NW. Montana northward and westward in Alberta, British Columbia, Mackenzie, Yukon, and Alaska, to 171° W. There is no specific type locality. The plants described by Brown and Richardson, including collections by Parry and Ross, were taken in the eastern Arctic, from Baffin Bay westward as far as Melville Island. The varieties all occur still farther south, in both East and West.

Distribution is presented here in two principal divisions, Eastern and Western. Eastern extends from the Atlantic Ocean westward to Long. 102° W, the boundary line between Manitoba-Saskatchewan and Keewatin-Mackenzie. It also contains all of the principal arctic islands of Franklin District except Victoria Isl. and Banks Isl. Western extends from Long. 102° W to the Pacific Ocean and Bering Sea. It extends south into the United States in the Rocky Mountains. The species apparently does not occur in the southern area between the west coast of Hudson Bay and the western mountains.

Many specimens from this entire area are cited herewith, in order that students may become acquainted with this widely distributed but little-known species. Schneider's brief description and failure to cite any specimens tended to focus attention on his three new varieties and cause neglect of the species itself. Most of the specimens cited were distributed as *S. anglorum* or as one of its varieties. Where distributed under other names, these are given in parentheses.

Nearly all of the specimens cited under the species or each of the varieties are in the herbarium of the writer (CRB), and/or in the Langlois Herbarium of the Catholic University of America (CU) and the U. S. National Herbarium (USN). Unfortunately, not all of those in the herbarium of Catholic University are indicated by "(CU)" in these lists. This is partly because the lists had been prepared before that material was studied and partly because not all of the University collections are yet mounted. In general, all specimens collected by Pere A. Dutilly and Dr. Hugh O'Neill, either alone, together, or with others, are deposited there. A few specimens recently studied are in

the herbariums of the U. S. Forest Service (USFS) and the New York State Museum (NYSM).

Many other specimens which certainly belong within the species are not cited here. Some, previously determined by the writer, are not now immediately available for rechecking. Others, studied again recently, belong to the species but are too juvenile or too fragmentary to be assigned with certainty to any variety. Most of the collections of the Canadian Arctic Expedition, 1913-1918 (Frits Johansen) are in this class. Another source of confusion with these small arctic plants is the frequent inclusion of more than one variety under a single collection number. This was especially true of the (unnumbered) collections of J. A. Allen on Mt. Albert, Gaspe Peninsula, Quebec, in 1881, cited by Schneider under varieties *kophophylla* and *araioclada*.

Eastern Distribution (Atlantic Ocean to Long. 102° W.).—LABRADOR (East Coast): Battle Island (Harbor) and Great Caribou Isl. (52° 15′ N), *Potter & Brierly* 8503, 8504 in 1934 (CRB); Domino Harbor, Island of Ponds (53° 28′ N), *Dutilly, O'Neill, & Duman* 7133 in 1939 (CRB); Davis Inlet (55° 52′ N), *D., O'N., & D.* 7626 in 1939 (CU); Nain (cir. 56° 35′ N), *Mrs. F. W. Peacock* 80 in 1945 (CRB); Port Manvers (56° 58′ N), *G. Gardner* 321 in 1939 (CRB); Cape Mugford (57° 55′ N), *Gardner* 430 in 1939 (CRB); Mugford Tickle (57° 55′ N), *Potter & Brierly* 8571 in 1934 (CRB); Eclipse Sound (58° 50′ N), *Gardner* 480, 483, 516 in 1939 (CRB); Mt. Elliott (59° 11′ N), *D., O'N., & D.* 7859 in 1939 (CRB); *Gardner* 442, 443, 444, 446 in 1939 (CRB); Grenfell Tickle (between Eclipse Sound and Joksut Inlet), *Potter and Brierly* 8601 in 1934 (CRB).

BAFFIN ISLAND (Franklin Dist.): Resolution Isl., Acadia Cove (61° 18′ N, 64° 53′ W), *A. Dutilly* 9283, 9284, 9286, 9287 in 1941 (all CRB); *E. P. Walker* 780 in 1937 (CRB); Frobisher Bay, Brewster Point (62° 55′ N, 65° 55′ W), *Walker* 913 in 1937 (CRB); Lake Harbor (62° 50′ N, 69° 52′ W), *N. Polunin* 2141 in 1934 (CU); *N. B. Sanson* 6 in 1938 (CRB); Dorset (64° N, 76° W), *Dutilly* 980 in 1936 (CRB); Cumberland Sound, Pangnirtung (66° 8′ N, 65° 28′ W), *Dutilly* 9463, 9464 B, 9466 in 1941 (all CRB); Hoffman Cove (69° 35′ N, 67° 25′ W), *R. W. Bartlett* 230 in 1938 (USN); Clyde River, Clyde (70° 26′ N, 68° 50′ W), *Dutilly* 9364 in 1941 (CRB); *N. B. Sanson* 2 in 1938 (CRB); Pond's Inlet (72° 50′ N, 76° 40′ W), *Dutilly* 1139 in 1936 (CRB, CU); Strathcona Sound, Admiralty Inlet (No. Baffin, about 85° W), *J. D. Soper* 366 in 1923 (CRB).

GREENLAND: East Greenland, Manby Peninsula (69° +′ N), *R. W. Bartlett* 352 in 1939 (USN); Franz Josef Land, *R. H. Menzies* (Louise A. Boyd. Exped.) in 1931 (3 unnumbered colls., CRB). NW. Greenland, Salmon Lake region (77° 23′ N, 67° 30′ W), *R. W. Bartlett* 157 in 1938 (USN); "Thule," North Star Bay (76° 30′ N, 68° 50′ W), *W. E. Ekblaw* 241 in 1914 (USN); Northumberland Sound (77° 25′ N, 72° 30′ W), *Bartlett* 213 in 1938 (USN); Etah (area) (78° N, 72° 30′ W), *Bartlett* 183 in 1938 (USN); *Walter Koelz* 157 in 1925 (USN); *J. D. Soper* 205 (111440) in 1923 (CRB, CU).

Hudson Bay (East Coast) and Hudson Strait (South Coast). QUEBEC (Ungava) and KEEWATIN DIST., NWT. (Offshore Islands in Hudson Bay, 78° - 80° W): Cape Jones Isl. (54° + N), *G. Gardner* 1187 in 1939 (CRB); Bill of Portland Isl. (55° 40′ N), *Gardner* 1127 in 1939 (CRB); Frazier Isl. (58° 15′ N), *Dutilly, O'Neill, and Duman* 87850 in 1939 (CRB, CU); *Gardner* 1028 in 1939 (CRB); Port Harrison (Ungava) (58° 24′ N), *D., O'N., & D.* 87614 in 1939 (CRB, CU); *Gardner* 933, 959 in 1939 (CRB); *M. O. Malte* 120817 in 1928, 127039 in 1933 (both USN); North Sleeper Isl. (59° 17′ N), *D., O'N., & D.* 87541 in 1939 (CRB); *Gardner* 844, 846 872, 874, 875, 902, 903, 904, 905, 906 in 1939 (CRB); Pattee Isl. (59° 42′ N) *Gardner* 841 in 1939 (CRB); Gilmore Isl., Ottawa Isls. (59° 50′ N), *Gardner* 832, 833, 834,

836, 839 in 1939 (CRB); Ivuyivik (Nuvuk), Ungava (62° 25′ N), *D., O'N., & D.* 87366 in 1939 (CRB); *Gardner* 782 in 1939 (CRB). HUDSON STRAIT: Wakeham Bay (61° 35′ N, 71° 58′ W), *A. Dutilly* 6030 in 1938 (CU); *G. Gardner* 658, 659, 660 in 1939 (CRB); *M. O. Malte* 120232, 120235, 120251 in 1928 (CU); Diana Bay (61° N, 69° 42′ W), *Gardner* 603, 620, 621, 622 in 1939 (CRB).

Hudson Bay (West Coast and Offshore Islands). ONTARIO: Sutton River (Trout R.) (55° 16′ N), *A. Dutilly* 16970 in 1946 (CU); No locality (56° N), *J. M. Macoun* on Aug. 11, 1886 (CRB). MANITOBA: Churchill (58° 40′ N), *N. B. Sanson* 10 in 1938 (CRB). KEEWATIN DIST., NWT.: Rankin Inlet (62° 45′ N), *J. M. Macoun* 79162 in 1910 (CU); Igluliguar (63° N), *Dutilly* 9074 in 1941 (CRB); Chesterfield Inlet (63° 25′ N), *Dutilly* 600 in 1936 (CRB); 4452 in 1937 (CU), 6706a in 1938 (USN); *M. O. Malte* 120483, 120517 in 1928 (CU); Southampton Isl. (cir. 64° N, 82° W), *Dutilly* 780 in 1936 (CRB); Melville Pen., (at head of Ross Welcome) Repulse Bay (66° N, 86° W), *Dutilly* 6826 in 1938 (CU).

FRANKLIN DIST. (mostly arctic islands): Somerset Isl., Ft. Ross (72° N, 94° W), *A. Dutilly* 9344, 9345 in 1941 (CRB); *N. B. Sanson* 8 in 1938 (CRB); Devon Isl., Dundas Harbor (74° N, 82° W), *Duvall & Handley* 65A, 65B in 1946 (CRB), *J. D. Soper* 272 (111242) in 1923 (CU); Cape Saumarey (77° 51′ N) *J. W. Goodsell* (Peary Arctic Club Exped.) 26 in 1908 (USN)); Smith Sound (Gale Point, Port Foulke, or T(J?)essuissak, 78°-82° N), *I. I. Hayes* 42 in 1861 (USN, 2 sheets, as *S. arctica* Pallas).

Western Distribution (Long. 102 W to Pacific Coast). U. S., MONTANA: GLACIER NATL. PARK, Vicinity of Grinnell Glacier. *F. C. Manale)* 16758 in 1919; vicinity of Gunsight Pass. *Standley* 18091 in 1919 (both CRB, USN). Canada, S.W., ALBERTA (S.W.): mostly BANFF NATL. PARK, Lake Agnes, *Malte & Watson* 1146, 1147, 1149 (116831, 116832, 116834) in 1925 (all CRB); Mt. Coliseum, Nordegg, *Malte & Watson* 1490 (116861) in 1925 (CRB); vicinity of Mountain Park, *Malte & Watson* 2075, 2267, 2272 (116898, 116941, 116945) in 1925 (CRB); Bow Pass, *W. C. McCalla* 6634a in 1941 (CRB); Simpson Pass summit, *N. B. Sanson* 15, 16 in 1913; Lake Minnewanka, *Sanson* 27 in 1913; Sunshine Chalet, *Sanson* 30, in 1913 (all CRB); JASPER NATL. PARK, Shovel Pass, *J. M. Macoun* 95807 in 1918 (CU). BRITISH COLUMBIA (S.E.): mostly YOHO NATL. PARK, Wapta Glacier, *Edith M. Farr* 925 in 1905 (CRB); Ross Lake, *McCalla* 8462 in 1944 (CRB); N.W., Mountains 10 miles south of Telegraph Creek, *T. T. McCabe* 8886 in 1941 (CRB); Cassiar Dis.., Mtns. near head of Ingenika R., *Preble & Mixter* 686 in 1910 (USN).

Canada, N.W., MACKENZIE TERR.: Artillery Lake (63° N, 108° W), *Seton & Preble* 78 in 1907 (CRB); Liverpool Bay (129° W), *A. E. & R. T. Porsild* 2864 in 1927 (CU); Port Brabant (132° W), *Dutilly* 18411 in 1940 (CU), Driftwood River (Mackenzie Delta) (68° N, 135° W), *Dutilly* 18086a in 1940 (CU). FRANKLIN DIST.: Victoria Isl., Willows Patch near Collinson Point (71° N, 117° W), *Dutilly* 18683, 18761 in 1940 (CRB). Banks Isl., De Salis Bay (72° N, 120° W), *Dutilly* 18958, 18960 in 1940 (CRB). YUKON TERR.: Herschel Isl. (139° W), *Dutilly* 18278 (CRB), 18280 (CU) in 1940.

ALASKA: Russell Isl. (SE., about 60 ° N, 140° W), *Cooper and Andrews* 152 A in 1929 (CU); MT. MCKINLEY NATL. PARK, *W. A. & C. B. Setchell* 180a in 1931 (CRB); *David Kaye* 7 in 1932 (CRB); Steese Highway (NE. of Fairbanks), Eagle Summit, *Setchells* 535, 538 in 1932 (CRB); Seward Peninsula, Nome, (171 ° W), *G. N. Jones* 9042 in 1940 (CRB).

1 a-c. VARIETIES OF SALIX ANGLORUM CHAMISSO

In his treatment of *Salix anglorum* Chamisso, in 1918, Schneider (Bot. Gaz. 66: 126-137) described three new varieties in great detail. To variety *kophophylla* he allotted 48 lines of description, to var. *araioclada* 28 lines, and

to var. *antiplasta* 22 lines. These figures contrast with the 11 lines of description for the misunderstood species itself. This neglect of the species and undue emphasis on the varieties has been one large factor in the prevailing lack of knowledge of the species. Another factor is Schneider's peculiar, incomplete, and sometimes misleading, method of comparing the varieties with the parent species. This will be illustrated in connection with the discussion of each variety.

For neither the species nor any of the three varieties did he give measurements of style length, although he did for nearly every other organ. For the species, he said: "stylus longitudine varians" and for each variety he said: "styli distincti". A style is distinct whether it is 0.3 or 3 mm. long. In this initial study of unfamiliar material, all from the arctic areas, he evidently was disturbed and confused by the variation noted on the same specimen and even in the same ament, caused by differentials in their rates of growth.

As in the case of two or more varieties of other species of *Salix*, it is not always possible to determine from juvenile specimens just which variety they will represent when more fully developed. There also will be some more fully developed specimens which will seem to lie almost on the border line between two varieties and may be easily assigned to either, depending on which characters seem most decisive in the impression of the moment.

All three of these varieties reach the most southern extension of their eastern range on Mt. Albert, in Gaspé County on Gaspé Peninsula, south of the St. Lawrence River in Quebec. Mt. Albert is the type locality for varieties *araioclada* and *antiplasta*, while the type of variety *kophophylla* came from NW. Newfoundland. The first two have their most extensive distribution in the far West. All three of the varieties differ from the species chiefly in having smaller leaves but these also are of somewhat different shape, especially in varieties *kophophylla* and *antiplasta*.

1a. Variety *kophophylla* Schneider

Salix anglorum var. *kophophylla*, nov. var. Camillo Schneider, Bot. Gaz. 66: 130-133. 1918.

Salix arctica Pallas (in the broadest sense, including *S. anglorum* Chamisso), var. *kophophylla* (Schn.) Polunin, Journ. Bot. 77: 271, 1939; Polunin (Bot. Canad. East. Arctic), Natl. Museum Canad. Bull. 92: 157, 1940.

Similar to the species in habit, and branchlet and bud size, color, and pubescence (perhaps more quickly glabrate or glabrous), and in the floral organs, but with smaller and rounder leaves and usually shorter peduncles and aments. Stipules (if any) and petioles as in the species; blades chartaceous, broadly elliptical to broadly oval, obovate, ovate-rotund, or suborbicular, 1.5-3 or 3.5 cm. long, 1.2-2.5 or 3 cm. wide, apex short-acute to plicate-apiculate to rounded, (apical leaves sometimes ovate, acute), base broadly cuneate to rounded or sometimes subcordate, color and reticulation as in the species; aments shorter but dense, 1-2.5 or 3.5 cm. long, on leafy peduncles 1-2.5 cm. long; other floral characters as in the species.

Although Schneider devoted 48 lines to the original description of this

variety, he then says (*loc. cit.*, p. 132): "In its rather short and dense catkins, at the base not or hardly loosely flowered, this variety approaches typical *S. anglorum*, but differs in its firmer, more rounded, and soon glabrous leaves and the glabrate twigs, in which characters it comes near to the following varieties." (*araioclada, antiplasta*).

The main character separating var. *kophophylla* from the species is the smaller and rounded blades. Schneider gave only an 11-line description of *S. anglorum* and, although he spoke of "ample material", he gave no evidence that he had studied the species closely. The leaves of *S. anglorum* seem about as firm as those of var. *kophophylla* but the aments average longer. Ament density seems about the same, including the base.

When he includes the "firmer, more rounded, . . . leaves" in the characters by which this variety approaches varieties *araioclada* and *antiplasta*, he is definitely misleading, because it is exactly by the rounder and firmer blades that var. *kophophylla* differs most from these other two varieties.

Var. *kophophylla* occupies the southeastern range of the species, from the Gaspé Peninsula of Quebec and NW. Newfoundland (type locality) along the east coasts of Labrador and Hudson Bay into Hudson Strait. It seems to be absent farther north unless represented by some very juvenile specimens. In the West, a few dubious specimens from Glacier Natl. Park in NW. Montana are referred here.

Eastern Distribution. QUEBEC: Gaspé Peninsula, GASPÉ CO., Mt. Albert (about 49° N, 64° W), *J. A. Allen* (as *S. arctica* var. *Brownei* And.) on July 23, 1881 (USN; 1 twig probably var. *araioclada* but not so annotated by Schneider); *Collins & Fernald* 60, 62 in 1905 (CRB, USN, 2 sheets of each); *Fernald, Griscom, Mackenzie & Smith* 25662 in 1923 (USN, leaves very variable, all finely reticulate above); *Adrien Gosselin* 3621 in 1936 (CRB); *Marie-Victorin, Rolland-Germain, Brunel, and Rousseau* 17607 (juv.), 17619 (mat.) in 1923 (USN);—SAGUENAY CO., (north shore of St. Lawrence R.), Ouapitagone Archipelago (60°-60° 40′ W), *Harold St. John* 90841 in 1915 (CU). NEWFOUNDLAND (NW), Bay of Islands, Blomidon Mts., *Fernald & Wiegand* 3233 (type) in 1910 (USN, paratype).

LABRADOR (east coast): Eclipse Harbor (Sound, 58° 50′ N), *Dutilly, O'Neill, & Duman* 87001 in 1939 (CRB, this No. in CU is var. *antiplasta*); *G. Gardner* 479, 515 in 1939 (CRB); Mt. Elliott (59° 11′ N), *Gardner* 447 in 1939 (CRB); Komaktorvik Fiord (59° 14′ N), *D., O'N., & D.* 7867 in 1939 (CU); Clark's Harbor (60° 14′ N), *D., O'N., & D.* 87038 in 1939 (CRB, CU); *Gardner* 555, 556, 557 in 1939 (CRB); Bowdoin Harbor (60° 20′ N, 64° 30′ W), *Potter & Brierly* 8577, 8578, 8579, 8580, 8581 in 1934 (all CRB). FRANKLIN DIST. (Hudson Strait): Port Burwell (60° 25′ N, 64° 45′ W), *M. O. Malte* 126819 in 1933 (CRB), *N. B. Sanson* 1 in 1938 (CRB); Button Isls.. Lacey Isls. (60° 50′ N, 64° 30′ W), *Potter & Brierly* 8583, 8584 in 1934 (CRB); Resolution Isl. (61° 20′ N, 64° 53′ W), *A. Dutilly* 9282, 9288 in 1941 (CRB, CU).

KEEWATIN DIST., offshore islands, east coast of Hudson Bay (for lat. & long. see under *S. anglorum*): Cape Jones Isl., *Dutilly, O'Neill, & Duman* 97061, 97069 in 1939 (CRB, CU); Frazier Isl. (opp. Hopewell Sound), *Gardner* 1027 in 1939 (CRB); North Sleeper Isl., *Gardner* 843, 866 in 1939 (CRB). QUEBEC (Ungava): "Ungava," *L. M. Turner* 4817 (as *S. arctica* var.), no locality or date (USN); Ivuyivik (Nuvuk), *Gardner* 784, 785, 788 in 1939 (CRB); Diana Bay, Hudson Strait, *D., O'N., & D.* 87114 in 1939 (CRB, CU); *Gardner* 558, 561, 580 in 1939 (CRB).

Western Distribution. U.S., MONTANA: GLACIER NATL. PARK, Swiftcurrent Pass, *P. C. Standley* 16265 in 1919; vicinity of Sexton Glacier, *Standley* 17218, 17251

(CRB) in 1919 (all USN). These western specimens have more slender branchlets and smaller, thinner leaves, and both branchlets and leaves are glabrate-glabrous from the first.

1b. Variety *araioclada Schneider*

S. anglorum Chamisso, var. *araioclada* Schneider, Bot. Gaz. 66: 133-(134). 1918; Ball in Standley (Fl. Glacier Natl. Park), Contrib. U. S. Natl. Herb. 22: 322. 1921. Titus Ulke (A Flora of Yoho Park, Brit. Columbia), Catholic Univ. of Amer., Biol. Lab. Bull. 14: 64, 1934.

Salix arctica R. Brown, var. *petraea* Andersson, Macoun, Cat. Canad. Pl. 1(3): 445, 1886 (partly var. *araioclada*, partly var. *antiplasta*).

S. petrophila of some American authors, in part, not Rydberg.

Habit as in the species; branchlets more slender and yellowish, less pubescent when young and more quickly glabrous, sometimes pruinose; bud scales more yellowish and glabrous, sometimes pruinose; stipules none (if rarely present, smaller); blades thinner, elliptic-oval, elliptic-obovate, or oval-obovate, 1.5-3 or 4 (rarely 5) cm. long, 1-2 or 2.5 (rarely 2.9) cm. wide, apex mostly obtuse to rounded or rarely retuse, sometimes apiculate or plicately so, base broadly cuneate to rounded, margin entire, color and venation as in the species; very young leaves more or less pubescent to glabrous above, more or less pilose and quickly glabrous beneath. Floral organs much as in the species; aments seldom exceeding 5.5 cm. long, often lax or distantly-flowered at base, and sometimes laxish throughout; scales obovate and rounded to oval and sometimes acute or acutish at apex, mostly about 2 mm. long; capsules 5-7 or rarely 8 mm. long.

Variety *araioclada* differs from the species in twigs more slender, yellowish, and glabrous; in blades thinner, smaller, and more consistently obovate, the younger more quickly glabrous; in aments usually somewhat shorter (not "longer" as stated by Schneider), and lax at base; and the shorter and sometimes narrower and rarely acutish scales. Of this variety, Schneider said (p. 134):

> This peculiar variety differs from the type chiefly in the less pubescent, mostly much more elongated and yellowish twigs, in the almost glabrous young leaves, and in its aments, which, on the average, are longer and thinner, at least much more loosely flowered toward the base. It is, apparently, closely connected with variety *kophophylla*, which as a whole has firmer leaves and denser and shorter catkins, but in its glabrous character comes nearer to var. *araioclada* than to the typical *anglorum*. See also my remarks under the following form. (*antiplasta*)

Var. *araioclada* has a wider range than the species in the south but does not penetrate commonly into the arctic areas and seems not to occur at all in the Southwest. In the East, it extends from the type locality on Gaspé Peninsula, Quebec, north on both sides of the Labrador Peninsula to southern Baffin Island, with one occurrence in northern Ellesmere Island (76° 20' N). In the West, it ranges from Colorado, Utah, and Nevada (elev. 9000-12000 ft.), and Wyoming, Montana, Idaho, and Oregon (elev. 6000-10000 ft.), to the southern mountains of Alberta and British Columbia (5500-9000 ft. elev.), with one occurrence on Banks Island (72° N, 120° W). The type locality is Allen's Ravine. Mt. Albert, Gaspé Co., Quebec. The type is *Fernald & Collins* 505 and the staminate paratype is their 500, both in 1906 (Gray).

Eastern Distribution, Atlantic Ocean to Long. 102° W. Canada, QUEBEC: Gaspé Peninsula, GASPÉ Co., Mt. Albert, *J. A. Allen*, July 26-Aug. 9, 1881 (CRB, USN mixed with var. *kophophylla*); *Fernald & Collins* 61 in 1905 (CRB, USN, 2 sheets annotated by Schneider as var. *antiplasta*); 506 in 1906 (USN); *Fernald, Griscom, Mackenzie, & Smith* 25660, 25661 in 1923 (CRB); *Ernest Lepage* 1149 in 1939 (CRB); MATANE Co., Mt. Blanc, *Lepage* 3466 in 1942 (CRB); Yankee Harbor, *Howard Cleves* 24 in 1927 (CRB, fragm.). LABRADOR (East Coast): Indian Tickle (53° 30′ N), *David Potter* 8638 in 1937 (CRB); Black Isl. near Cartwright (53° 40′ N), *G. Gardner* 127 in 1938 (CRB), Bay south of Joksut Harbor (60° 12′ N), *Potter* 8665a in 1937 (CRB). FRANKLIN DIST. (Hudson Strait & Baffin Isl.): Port Burwell (60° 25′ N, 64° 45′ W), *A. Dutilly* 1697 in 1936 (CRB); Button Isls., Lacey Isl. (60° 50′ N, 64° 30′ W), *Potter & Brierly* 8589 in 1934 (CRB); Resolution Isl., Acadia Cove (61° 20′ N, 65° W), *Potter* 8665 in 1937 (CRB); Baffin Isl., Frobisher Bay, Point Brewster (62° 55′ N, 65° 55′ W), *Potter* 8672 in 1937 (CRB).

Hudson Bay (West Coast) and Northward. ONTARIO: Cape Henrietta Maria (55° 10′ N, 82° 30′ W), *R. H. Smith* in 1944 (CRB, USN); Sutton River (Trout R.), (55° 15′ N, 84° 30′ W), *Dutilly & Lepage* 16943 in 1946 (CRB). KEEWATIN DIST.: Fairway Isl., off Chesterfield Inlet (63° N, 90° 40′ W), *Dutilly* 337 in 1936 (CRB); Winter Isl., Point Fisher (south end of Melville Penin.), (66° N, 83° W), *Dutilly* 6923 in 1938 (CRB). FRANKLIN DIST.: Ellesmere Isl., Craig Harbor (76° 20′ N, 81° 30′ W), *Dutilly* 1257 in 1936 (CRB).

Western Distribution, Long. 102 W. to the Pacific Ocean. These specimens mostly were distributed as *S. petrophila* Rydberg; if otherwise, the name is given. U.S. COLORADO: CLEAR CREEK Co., *J. H. Christ* 2954B in 1936 (CRB); CHAFFEE Co., Mt. Harvard, *C. L. Shear* 3285 in 1896 (USN *vidi* Schn.). UTAH: UTAH Co., *Bassett Maguire* 11500A in 1939 (CRB); CACHE Co., *Maguire* 16193 in 1938 (CRB); *R. S. Snell* 1021 in 1938 (CRB). NEVADA: ELKO Co., *A. H. Holmgren* 1407 in 1941 (CRB, too juvenile for certainty). WYOMING: ALBANY OR CARBON Co., Medicine Bow Peak, *R. J. Davis* 262-W in 1934 (CRB); near this Peak, elev. 9800 ft., *Leon Kelso* 509 in 1930 (USN); FREMONT-SUBLETTE Cos., *Wind* R. Mts., head of Late Fork, *Vernon Bailey* (as *S. Brownii* var. *petraea* Bebb) on Aug. 21, 1893 (USN, annot. Schn.); SUBLETTE Co., *E. H. & L. B. Payson* 4464 in 1925 (CRB); TETON Co., *Merrill & Wilcox* 1073 in 1901 (CRB), *O. J. Murei* 67 in 1933 (CRB); NW. Wyo., Two-Ocean Mt., *Louis Williams* 1360 in 1933 (CRB); PARK Co., *Hitchcock & Muhlick* 13508 in 1945 (CRB), *Rollins & Muñoz* 2848 in 1939 (CRB, USN), Beartooth Mtns., *L. C. & Rua Williams* 3703 in 1937 (CRB, USN); Big Horn Mts., BIG HORN (?) Co., *L. O. & Rua Williams* 3217B in 1936 (CRB, CU), *Williams and Griffiths* in Aug., 1898 (CRB); JOHNSON (?) Co., head Big Goose Creek, *Frank Tweedy* 20 (as *S. Brownii* Bebb var. *petraea* (And.) Bebb) in 1893 (USN, annot. Schn.); SHERIDAN Co., Hunt Mt., 10,000 ft. elev., *J. G. Jack* on July 21, 1900 (USN, mixed with *S. tenera* Hook.).

MONTANA: SWEETGRASS Co., *Hitchcock & Muhlick* 13275B in 1945 (CRB); MADISON Co., Old Hollowtop, elev. 9000 ft., near Pony, *Rydberg & Bessey* 3923 in 1897 (USN, *vidi* Schn.); PARK Co., Absaroka Natl. Forest, *C. L. Kalitowski* 14 (F. S. 92773) in 1941; *C. L. Larsen* 213 (F. S. 92775) in 1941 (both USFS); ——— Co., above Stanton Lake, elev. 7500 ft., *R. S. Williams* 1030 (as *S. arctica* R. Br., var *petraea* And.) in 1894 (USN, annot. Schn.). GLACIER NATL. PARK, *Vernon Bailey* on July 19-22, 1917 (USN, 3 fragments on one sheet; annot. by Schn. (Bot. Gaz. 66: 135, 1918) as a form coming near *S. anglorum*); *C. L. Hitchcock* 1925, 2033 in 1933 (CRB), *B. Maguire* 681 in 1932 and 5318 in 1934 (CRB), *L. S. Rose* 32570 in 1932 (CRB, CU), *P. C. Standley* 15408, 15453, 16191, 16203, 16204 (USN), 16212 (USN), 16323, 16370 (mixed with var. *antiplasta*), 16371, 16430, 16453, 16780, 16802, 17225 in 1919 (all in CRB). IDAHO: BLAINE Co., *J. W. Thompson* 13582 in 1936 (CRB); CUSTER Co., *R. J. Davis* 1715 in 1939 (CRB), *Hitchcock & Muhlick* 11220 in 1944 (CRB). OREGON: WALLOWA Mtns., *W. C. Cusick* (as *S. reticulata* var. *nivalis*) 3219 in 1907 (CRB, USN); *M. E. Peck* 18495, 18540 in 1934 (CRB).

Canada, ALBERTA (southern): WATERTON LAKES NATL. PARK, *W. C. McCalla* 7234 in 1942 (CRB); BANFF NATL. PARK (and vicinity), Head of Ptarmigan Valley, *Stewardson Brown* 398 in 1906 (USN); *O. S. Day* through Edith M. Farr (as *S. petrophila*) in 1904 (CRB); Pipestone Pass, head of Bow R., *I. M. Cowan* 29 through G. A. Hardy in 1943 (CRB); Lake Louise, *E. M. Farr* 855, 856, 857, 860 (all as *S. petrophila*) in 1905 (all CRB); *J. Macoun* 94320 (as *S. saximontana*) in 1897 (CRB), 68881 (as *S. petrophila*) in 1904 (CRB); *Malte & Watson* (different localities), 1143, 1148, 1491, 2107, 2277, 2280, 2282, 2328 (116828, 116833, 116862, 116902, 116946, 116947, 116948, 116950, respectively) in 1925 (all CRB); Mt. Aylmer, *W. C. McCalla* (as *S. petrophila*) in 1899 (USN*); Bow Pass, *McCalla* 6634 in 1941 (CRB), 7069 in 1942 (CRB)); Slope opp. Mt. Aylmer, *N. B. Sanson* (as *S. petrophila*) in 1901 (CRB, mixed with var. *antiplasta*); Vermilion Mtn., *Sanson* (as *S. petrophila*) in 1902 (CRB); Different localities, *Sanson* 1918, 2050, 2113, 2115, 2129, 2158, 2166, 2185 in 1909-1913, 14 in 1913, 107 in 1926, 8 in 1939 (all CRB); JASPER NATL. PARK, *I. M. Cowan* (Mt. Southesk) 22 in 1945 (CRB); *J. M. Macoun* 95398, 95401 in 1917 (CRB); *E. H. Moss* 4874a, 4874b, 4914, 4977 in 1939 (CRB).

BRITISH COLUMBIA (mostly YOHO NATL. PARK): *Edith M. Farr* 901, 903, 910, 929, 931, 950 (all as *petrophila*) in 1905 (all CRB); *G. A. Hardy* 5, 13 in 1944 (CRB), 18276 in 1945 (CRB); *W. B. Johnstone* 414 in 1943 (CRB); *J. Macoun,* Kicking Horse Lake (as *S. arctica* var. *petraea*) in 1885 (CRB, mixed with var. *antiplasta*); Lake O'Hara, *J. Macoun* 68882 (Labeled "Plants of Rocky Mountain Park") in 1904 (CRB); *W. C. McCalla* 7056 in 1942, 8463 in 1944 (both CRB); *Titus Ulke* 8 in 1928 (CU); Moose Pass, *J. H. Riley* 42 in 1911 (USN, annot. by Schneider as intermediate between var. *araioclada* and *S. nivalis* var. *saximontana* but it shows no traces of such admixture); Rogers Pass, Selkirk Mtns., *J. Macoun* 18a (as *S. Brownii petraea*) in 1890 (USN*); Selkirk & Rocky Mtns., about 51° 30′ N), *R. T. Shaw* 300 in 1904 (USN, *vidi* Schn.); Selkirk Mts., 51° 45′ N, *C. H. Shaw* 962 (as *S. glauca* L.) in 1905 (USN, annot. Schn.). Kootenay Park, *N. B. Sanson* A in 1940 (CRB); Lime Dyke, *E. W. Scheuber* on Aug. 15, 1904 (USN*); Downie Creek, *C. H. Shaw* 1138 (as *S. Brownii*) in 1905 (USN*). FRANKLIN DIST.: Banks Isl., De Salis Bay (72° N, 120° W), *A. Dutilly* 18955a in 1940 (CRB). Specimens regarded as *S. petrophila* by Schneider are indicated by "*vidi* Schn." when distributed under that name, and by "annot. Schn." when distributed under some other name. The * indicates annotation as var. *araioclada.*

1c. Variety *antiplasta* Schneider

Salix anglorum Chamisso, var. *antiplasta* Schneider, Bot. Gaz. 66: 134-135, 1918.

Salix arctica Pallas, var. *petraea Andersson,* in DC. Prodr. 16(2): 287, 1868 (doubtful; Andersson's description probably is based on specimens of var. *antiplasta* and of the *S. desertorum-S. glaucops* complex. See discussion below).

Salix arctica R. Brown, var. *petraea Andersson,* Macoun, Cat. Canad. Pl. 1(3): 445, 1886 (partly var. *antiplasta,* partly var. *araioclada*).

Salix petrophila Rydberg, Bull. N. Y. Bot. Garden 1: 268, 1899; Rydberg (Fl. Colo.), Colo. Agric. Expt. Stat. Bull. 100: 96, 1906; Rydberg, Fl. Rocky Mtns. & Adjac. Plains 198, 1917; Ball in Coulter & Nelson, New Man. Rocky Mtn. Bot. 136, 1909; Schneider, Bot. Gaz. 66: 135-136, 1918; Ball in Standley (Fl. Glacier Natl. Park), Contrib. U.S., Natl. Herb. 22: 322, 1921; Smith (Willows of Colorado), Amer. Midl. Nat. 27: 243-244, 1942.

Habit as in the species; branchlets more slender, 0.5-1 dm. long, somewhat pubescent when young, becoming glabrous, yellowish to brownish, sometimes pruinose; bud scales to 7 mm. long, yellowish, glabrate or mostly glabrous; stipules none; younger petioles somewhat pubescent; blades relatively narrow, elliptic-oblong to mostly elliptic-oblanceolate or the lower narrowly obovate, practically entire, 1.5-3.5 or 4.5 cm. long, 0.7-1.5 or 1.8 cm. wide,

acute to abruptly acute, plicately acute, or plicately apiculate, or sometimes obtusish at apex, acute to somewhat rounded at base, green above, glaucescent to glaucous and rather strongly veined and somewhat reticulate beneath, the young sparingly pubescent above and more or less pilose beneath, the margins often remaining thinly pubescent to ciliate. Aments coetaneous to somewhat serotinous, leafy-pedunculate, the staminate 1.5 to 4 cm., the pistillate 2-4 or 5, rarely 6 cm. long, and about 1.2-1.4 cm. wide in fruit. lax at base and sometimes laxish throughout; scales obovate or oval, rounded or sometimes acutish at apex, blackish or brownish toward base, more or less pilose, especially within; ovaries white-tomemtose, capsules lanceolate to ovate-lanceolate, sessile or subsessile, 5-6.5 or rarely 7 mm. long, gray-tomentose; styles and stigmas as in the species or slightly shorter.

In publishing his new variety *antiplasta*, Schneider cited but five specimens, all collected by Fernald and Collins on Mt. Albert, Gaspé Peninsula, Quebec, in 1905 and 1906. Why did he fail to recognize its identity with *S. petrophila* Rydberg? He had been studying western material because he had just assigned several specimens from the Canadian Rockies to his preceding variety *araioclada*, for which Mt. Albert also was the type locality. Here is what he said about *antiplasta* and its relationships:

> At first sight this variety much resembles *S. petrophila* in its habit, the shape of the leaves, and the yellowish color of the young twigs, but the leaves are of a deeper green on the upper surface and much paler and glaucescent on the lower surface, and do not differ in this respect from any other form of *S. anglorum*. . . . The two species meet each other in the Rockies of Alberta and British Columbia, and there also are certain forms in northern Montana and even in Wyoming which at present I am at a loss to determine. (p. 135).

Schneider then discusses *S. petrophila* Rydberg (pp. 135-136) and says (p. 136):

> *S. petrophila* differs from *S. anglorum* in the color of the pale or grayish green leaves, which are not distinctly paler and never whitish beneath. . . . As I have already said, there are some forms in the northern habitat of *petrophila* which I have not yet been able to interpret properly.

From these two statements it is clear that Schneider had a fixed idea that the leaf-blades of *S. petrophila* not only are paler green above but "are not distinctly paler and never whitish beneath". The fact is, however, that its fully opened leaves are always paler, practically always glaucescent ("whitish"), and often glaucous (white) beneath. In that very year, 1918, Schneider annotated scores of Rocky Mountain specimens as "*S. petrophila* Rydberg" and practically every one of them had leaves glaucescent to glaucous beneath. It is to avoid conclusions like these that the writer advocates the centripetal method of studying ample but questionable material.

What did Rydberg himself say about the leaves of his new *S. petrophila?* It was published merely as a new name for *Salix arctica* var. *petraea* Andersson, so Rydberg gave no full description but cited some 36 specimens, mostly from the United States, and stated:

> This should, I think, be regarded as a distinct species, differing from *S. anglorum* in the following respects: The leaves are narrower and greener, the branches are more slender and do not turn blackish in drying; the catkins are much smaller and narrower, and the

capsule is shorter, rather ovoid, and more densely villous. It is, however, much nearer to *S. anglorum* than the species of the Rockies that have been regarded as that species.

This comparison with *S. anglorum* is in general terms, without mention of actual shapes or measurements of organs. In his keys (p. 263), Rydberg separates *S. petrophila* by "Leaves obovate, catkins many-flowered", but he was comparing it with *S. tenera* Hooker (*S. cascadensis* Ckll.) and not with *S. anglorum*. In 1906 again (Fl. Colo., p. 93), his key reads: "Shrubs creeping, leafblades obovate to oblanceolate", but here also he was not comparing it with *S. anglorum* but with two wholly unrelated species. In 1917 (p. 190), he made the same comparison with *S. cascadensis* as in 1899. Thus, three times within 19 years, Rydberg keys his *S. petrophila* as having "obovate" leaves, which it does not, and insists that it is different from *S. anglorum*, which does have obovate leaves. This was standard practice for Rydberg, who almost never compared his novelties directly with the most closely related species.

Finally, it is by no means certain that Andersson's description of his variety *petraea* was based on plants related to those Rydberg included in his *S. petrophila*. The description (in Latin) reads: "leaves lanceolate, apex and base subequally attenuate, dark green throughout, scarcely paler beneath" (p. 287). He also describes the scales as "yellowish, narrow, apex fuscous" whereas the scales in all forms of *S. anglorum*, including *S. petrophila*, are blackish and broadish. It matters little now, but Andersson's description applies equally well to some forms of the *S. desertorum-S. glaucops* complex, of Section Glaucae, especially in habit (frutex humilis), leaf shape, and scales. Andersson refers only to a collection by Bourgeau and in the Selkirks, where Bourgeau collected, the *deseetorum-glaucops* complex is extremely abundant.

Variety *antiplasta* has a limited eastern distribution, from the Gaspé Peninsula of Quebec (type, Fernald & Collins 509) sparingly northward to central Baffin Island, and to a few points on both sides of Hudson Bay. In the West, it has a greatly extended southern range, from northern New Mexico, Colorado, and the northern parts of Utah and Nevada across Wyoming, western Montana, Idaho, and northeast Washington to southern Alberta and British Columbia. In the Far Northwest, it occurs sparingly, as noted. In elevation above sea level it ranges from 10,000 to 14,000 feet in Colorado and adjacent States to gradually lower elevations northward, and to practically sea level in the Arctic.

Eastern Distribution, Atlantic Coast to Long. 102° W. QUEBEC. Gaspé Pen., GASPÉ Co., Mt. Albert (elev. about 1000 m.) *Collins & Fernald* 61a in 1905 (CRB, USN). LABRADOR (East Coast, for latitudes see *S. anglorum*): Great Caribou Isl., *Potter & Brierly* 8505 in 1934 (CRB); Mugford Tickle, *P. & B.* 8575 in 1934 (CRB); Eclipse Harbor (Sd.), *Dutilly, O'Neill, & Duman* 87001 in 1939 (CU); this number in CRB is var. *kophophylla*); Grenfell Tickle, *P. & B.* 8600 in 1934 (CRB). FRANKLIN DIST.: Baffin Isl., Resolution Isl., Acadia Cove, *A. Dutilly* 9285 in 1941 (CRB); Cumberland Sound, Pangnirtung, *Dutilly* 9467 in 1941 (CRB).

Hudson Bay (East Side). KEEWATIN DIST. (offshore islands): Manitounok Isls., Boat Opening (55° 41′ N, 77° 55′ W), *Dutilly* 14245 in 1945 (CU); North Sleeper Isl., *Gardner* 847 in 1939 (CRB). QUEBEC (Ungava) Ivuyivik (Nuvuk), *Gardner* 787 in 1939 (CRB). Hudson Bay (West Side). KEEWATIN DIST.: 50 miles south

of Cape Eskimo (60° 25′ N, 94° 30′ W), *E. A. & A. E. Preble* 43 in 1900 (USN, paratype of *S. hudsonensis* Schn.); Chesterfield Inlet (62° 25′ N), *Dutilly* 222, 526, 527, 528 in 1936 (CRB, CU); Igluliguar (8 miles from Chesterfield Inlet), *Dutilly* 9066 in 1941 (CRB, CU); Sarpik Isl. (7 miles off the Inlet), *Dutilly* 4364 in 1936 (CRB); Wag Isl. (4 miles off the Inlet), *Dutilly* 4144, 4144a in 1936 (CRB, CU).

Western Distribution, U.S. and Canada from Lat. 102° W to the Pacific Ocean (as *S. petrophila* unless otherwise stated). NEW MEXICO: SANTA FE CO., Lake Peak, vicinity of Santa Fe, elev. 3780 m., *Bros. Arsene & Benedict* 16268B in 1926 (USN); MORA-RIO ARRIBA COS., Truchas Peak, elev. 12,500 ft., *P .C. Standley* 4790 in 1908 (USN); TAOS CO., Taos Mtns., elev. 11,400 & 12,600 ft., *Vernon Bailey* 861, 862 in 1904 (USN). COLORADO: (County designations may not be exactly accurate because peaks and ranges often are on boundary lines; counties given from south to north, and east to west): MINERAL CO., near Pagosa Peak, *C. F. Baker* 277 in 1899 (USN, *vidi* Schn.); *John Murdoch Jr.* 4830 in 1911 (CRB); SAN JUAN CO., San Juan Natl. For., *G. A. Loughridge* 311 (F. S. 72518) in 1934 (CRB); SAN MIGUEL CO., Telluride, elev. 13,000 ft., *Frank Tweedy* 265, 266 in 1894 (USN, *vidi* Schn.); Vallecito, *Whitman Cross* 71 in 1901 (USN, *vidi* Schn.); head of Vallecito, *F. H. Knowlton* 1 in 1903 (USN, *vidi* Schn.); SAGAUCHE CO., 13,000 ft. elev., Whitehouse Mt., *J. M. Coulter* on Aug. 9, 1873 (USN, as *S. arctica*, annot. Schn.); SAGAUCHE-GUNNISON COS., Marshall Pass, Gunnison Watershed, *C. F. Baker* 504 in 1901 (USN, *vidi* Schn.); CHAFFEE-GUNNISON COS., Alpine Tunnel, *W. Heustis* in 1905 (CRB, USN); GUNNISON CO., Mt. Carbon, *Ivar Tidestrom* 4055 in 1910 (CRB); LAKE CO., Mt. Massive, *W. W. Eggleston* 11893 in 1915 (USN); PARK CO., Hoosier Pass, *C. W. Penland* 1308 in 1935 (USN); South Park, *Penland & Hartwell* 1308 in 1935 (CRB); CLEAR CREEK CO., Gray's Peak, 14,000 ft. elev., *Geo. W. Letterman* (as *S. Brownii petraea*) on July 23, 1886 (USN); headwaters of Clear Creek, *H. N. Patterson* 136 (as *S. arctica* Pall.) in 1885 (USN, 2 sheets, annot. Schn.); GARFIELD CO., Wind R. Plateau, *F. J. Hermann* 5631 in 1933 (CRB); GRAND OR SUMMITT CO., Rocky Mts., Lat. 39° 41′ N., *Hall & Harbour* 520 (as *S. arctica* R. Br.) in 1862 (USN, annot. Schn.); GRAND CO., James Peak, *C. F. Cox* 406 in 1929, 570 in 1928 (CRB); LARIMER CO., (mostly in Rocky Mtn. Natl. Park), Iceberg Lake, *J. H. Christ* 846 in 1935 (CRB), *R. A. Schneider* 769 in 1937 (CRB); Longs Peak, *Walter Kiener* 1013 in 1931, 2261 in 1932, 5341 in 1937 (all CRB); above Loch Vale, *E. C. Smith* 1596, 1597 in 1942 (CRB); Trail Ridge, *Smith* 227A in 1933, 1634 in 1943 (CRB); JACKSON CO., North Park, *E. A. Barber* on Aug. 11, 1874 (USN, *vidi Schn.*); ROUTT CO., Ethel Peak, *L. H. Goodding* 1913 in 1903 (CRB, USN).

UTAH (elev. 9000-12,000 ft.): PIUTE CO., NE. of Delano Peak, *Bassett Maguire* 19730 in 1940 (CRB). PIUTE OR BEAVER CO. (?), Wasatch Mts., Bald Mt., elev. 11,000 ft., *M. E. Jones* 1241 (as *S. arctica petraea*) in 1879 (USN, annot. Schn.); UTAH CO., Mt. Timpanogos, *Maguire* 11508B in 1939 (CRB); DUCHESNE CO., Uinta Mts., head of west fork of Whiterocks R., *E. H. Graham* 10128 in 1935 (CRB, USN); SUMMIT CO., Uinta Mts., *Maguire et al.* 4061 in 1933, 14336a, 14447 in 1936 (all CRB); SALT LAKE CO., Big Cottonwood Canyon, *A. O. Garrett* 1549 in 1905 (USN); CACHE CO., Mt. Naomi area, *R. S. Snell* 1012 in 1938 (CRB); *Maguire et al.* 14195, 14196 in 1936 (CRB); *Maguire* 16192 in 1938 (CRB). NEVADA: ELKO CO., Ruby Mts., *A. H. Holmgren* 1741, 1743, 1916 in 1941 (CRB); *Percy Train* 4756 in 1940 (CRB); WASHOE CO., Mt. Rose, *Train* 4444 in 1940 (CRB). WYOMING (9000-12,000 ft. elev.): ALBANY CO., *Aven & Ruth Nelson* 2277 in 1936 (CRB); *R. C. Rollins* 1057 in 1935 (CRB); SUBLETTE CO., Saltlick Mtn., NE of Kendall, *E. B. & L. B. Payson* 2996 in 1922 (USN); LINCOLN CO., *Louis Williams* 1285 in 1933 (CRB); TETON CO., Teton Mtns., *Merritt Cary* 600 in 1910 (USN, as S. "heterophylla," annot. Schn.); near Leigh's Lake, *Merrill & Wilcox* 1073 in 1901 (USN, *vidi* Schn.); BIG HORN CO., Ten Sleep Lakes, *L. N. Goodding* 449 in 1901 (CRB, USN, mixed with *S. tenera, vidi* Schn.); *L. O. & Rua Williams* 3217 in 1936 (CRB); YELLOWSTONE NATL. PARK, Upper Falls of Yellowstone R., *Robert Adams* on Aug. 27, 1871 (2 sheets as *S. arctica Brownei* And. and *S. Brownii petraea* And., USN, annot.

Schn.); *H. S. Conard* 1280 in 1924 (CRB); *P. H. Hawkins* 902 in 1922 (USN); Amethyst Mtn., *F. H. Knowlton* (as *S. arctica* R. Br., var. *petraea* And.) in 1887 (USN, annot. Schn.); *J. N. Rose* 166, 382, 462, 588 (as *S. Brownii* or var. *petraea*) in 1893 (USN, annot. Schn.); (?) Co., Whirlwind Peak, elev. 10,500 ft., *Merritt Cary* 579 (as *S. tenera*) in 1910 (USN, annot. Schn.)

MONTANA: SWEETGRASS CO., *Hitchcock & Muhlick* 13275b in 1945 (USN, appr. var. *araioclada*). FLATHEAD CO., McDonald Peak, *M. E. Jones* 9143 in 1908 (USN, *vidi* Schn., mixed with var. *araioclada*); Sperry Glacier, *L. M. Umlach* on Aug 27, 1901 (USN, annot. Schn.); GLACIER NATL. PARK, *J. W Harshberger* on July 4, 1926 (USN); *A. S. Hitchcock* 11917 in 1914 (USN, annot. Schn.); *M. E. Jones* in 1910 (CRB); *Bassett Maguire* 682 in 1932 (CRB); *P. C. Standley* 15402 (CRB), 15420, 15453 (CRB), 16370, 17216 (CRB), 17278 (CRB), 17463 (CRB), 18049 in 1919 (all USN). IDAHO: BLAINE CO., Sawtooth Range, *J. W. Thompson* 13572 (USN), 13606 in 1936 (both CRB); CUSTER CO., Livingston Mine, *R. J. Davis* 667 in 1938 (CRB), Lost R. Mts., *Hitchcock & Muhlick* 11040 in 1944 (CRB). WASHINGTON: OKANOGAN CO., north of Hart's Pass, *Ownbey & Meyer* 2309 in 1940 (CRB, USN, appr. var. *araioclada*).

Canada, ALBERTA (SW), mostly BANFF NATL. PARK: Moose Mtn., *John Macoun* 94319 in 1897 (CRB); above Bow Pass, *W. C. McCalla* 7068 in 1942 (CRB); Kootenai Pass, *C. H. Morse* in 1920 (CRB); Simpson Pass, *N. B. Sanson* 2150 in 1904 (CRB), Sulphur Mtn., *Sanson* 1920 in 1912 (CRB), Upper Kananaskis Pass, *Sanson* 507 in 1922 (CRB), Sunshine Valley, *Sanson* 32 in 1942 (CRB); JASPER PARK: *W. P. Fraser* 7 in 1940 (CRB); *J. M. Macoun*, Fitzhugh Mtn., 95379, 95397 in 1917 (CRB). BRITISH COLUMBIA (SE): Paradise Valley, *W. B. Anderson* 2020 in 1923 (CRB); Paradise Mine, *G. A. Hardy* 7, 14 in 1944 (CRB); Yoho Valley, *McCalla* 7559 in 1943 (CRB); Mt. Odarsy, *Titus Ulke*, 11198 in 1927 (CU).

Canada, Western Arctic, FRANKLIN DIST.: Victoria Isl., Cambridge Bay & Mt. Pelley (69° N, 105° W), *A. Dutilly* 28097, 28100 in 1940 (CRB); Banks Isl., De Salis Bay (72° N, 120° W), *Dutilly* 18955 A & B in 1940 (CRB). MACKENZIE DIST. (Arctic coast): Atkinson Point (70° N, 131° 20′ W), *A. E. & R. T. Porsild* 2591A in 1927 (CRB, NMC); Richards Isl. (about 134° W), the *Porsilds* 2197B in 1927 (CRB, NMC); Port Brabant (Tuktuk, 132° W), *Dutilly* 18399, 18401 in 1940 (CRB). ALASKA: SE Coast, Alaska Glacier, *Cooper & Andrews* 178 in 1929 (CU); NE Coast, near Yukon boundary, Demarcation Point (141° W), *Dutilly* 18336 in 1940 (CRB).

1, ca. Variety **antiplasta** Schneider, forma **caespitosa** (Kennedy) n. comb.

Salix caespitosa Kennedy, Muhlenbergia 7: 135 (134-136). 1912.

Salix petrophila Rydberg, Bull. N.Y. Bot. Garden 1: 268. 1899 (in so far as California specimens are cited).

Salix petrophila Rydb., var *caespitosa* (Kennedy) Schneider, Bot. Gaz. 66: 136. 1918.

Forma *caespitosa* has the characters of var. *antiplasta*, including the narrowed and usually pointed leaves. It differs solely in that most of the leaves on a given plant retain the gray pubescence of the upper surface throughout the season. Commonly, however, a few of the leaves on most plants will become glabrate or glabrous above. The juvenile leaves of variety *antiplasta* also are normally gray pubescent and therefore the form cannot be recognized with certainty in the juvenile condition where it occurs within the range of the variety. Fortunately, variety and form have separate distributions, for the most part.

Kennedy afforded an excellent illustration of the making of species without studying plants, when he published his *S. caespitosa*. He had but one

collection, his No. 1173, a depauperate plant from Mt. Rose, Nevada. Of it, he says: "We have considered this Mt. Rose willow as *Salix petrophila* Rydberg, but in the first place it differs in having leaves elliptical and acuminate at both ends instead of "obovate". He quoted the word "obovate" and later referred to Rydberg's key.

Rydberg's errors in regard to his *S. petrophila* have been discussed above under variety *antiplasta*. Rydberg published no description but merely renamed *S. arctica* var. *petraea* Andersson. But Andersson had described his variety as having leaves lanceolate, attenuate at both ends. In keying his *S. petrophila*, in three different volumes Rydberg cites the leaves as "obovate" in two volumes and as "obovate to oblanceolate" in one. Rydberg originally cited some 35 specimens from Colorado to California and northward into Canada. A few of these do have obovate leaves but they belong to variety *araioclada* rather than to *antiplasta*. If Kennedy had looked in the herbarium, he would have known that the leaves of *S. petrophila* were not "obovate", but of exactly the same shape as those of his *caespitosa*.

Kennedy further says, in his discussion: "The leaves are all densely pubescent above, at least until the catkins are mature. . . . Rydberg, in his key, used 'leaves glabrous, or when young covered with long white hairs parallel to the midrib.' If the species in literature have been accurately keyed and described, then our plant shows characters sufficiently different for us to propose it as a new species."

Kennedy does not explain that the key characters on leaf hairiness quoted above were not used by Rydberg to set off his *S. petrophila* alone but to separate 15 of the 18 species assigned by him to Section Arcticae as he understood it. Actually, Rydberg had included species from three different Sections and three of the species so keyed have leaves permanently hairy. So much for studying books instead of plants. Although Kennedy discussed the leaves as being densely pubescent above, which is correct, he described them as "densely pilose" above, which is incorrect. They are thinly pilose beneath when young, as in all forms of *S. anglorum*. As Kennedy described only a single depauperate specimen, his measurements are all too small for more vigorous plants, which equal the measurements given for variety *antiplasta*. Finally, he described the blades as grey green beneath when actually they are paler to distinctly glaucescent beneath.

The principal range of forma *caespitosa* is in the Sierra Nevada of California, with the type locality on Mt. Rose in the adjacent Washoe Mountains of Washoe Co., Nevada. Single collections from the Wahsatch Mtns. of Salt Lake Co., Utah; the Teton Mtns. area of western Wyoming, and the Cascade Range in NW. Washington, represent far eastern and northern outposts. Juvenile specimens from the Ruby Mountains of NE. Nevada have densely pubescent young leaves but no older specimens with mature leaves densely pubescent have been seen.

Western Distribution Only. U.S., WYOMING: LINCOLN Co., Double-top Mtn. elev. 10,900 ft., headwaters of Snake River, (43° 10′ N, 110° 40-50′ W), *McDonald & Shannon* 62 (F. S. 55001) in 1926 (USFS. UTAH: SALT LAKE Co., Brighton, elev. 10,000 ft., *Bassett Maguire* 17432 in 1939 (CRB). NEVADA: WASHOE Co., Mt. Rose, elev. 10,000 ft., *P. B. Kennedy* 1173 (type) on Aug. 17, 1905 (CRB, USN, paratypes).

WASHINGTON: WHATCOM CO., Mt. Baker, elev. 6500 ft., *J. Wm. Thompson* 8089 in 1931 (CRB).

CALIFORNIA (southern, 10,000-12,000 ft. elev.): FRESNO CO., Sierra Natl. Forest, Evolution Lake, on slope of Mt. Darwin, *D. M. Bissell* on Sept. 20, 1932 (CRB); Evolution Creek watershed, *J. H. Hatton* 33 in 1912 (CRB); Silver Pass, *J. H. Hatton* 106, in 1912 (CRB); INYO CO., Mono Pass Trail, *A. S. Crafts* 465 in 1932 (CRB); Heart Lake, *Morris Halperin* 469 in 1932 (CRB); Rock Creek Lake, *F. W. Pierson* 9121 in 1930 (CRB); unnumbered in 1933 (CRB), 12952 in 1940 (CRB, larger leaves); west side of Morgan Pass, *J. Thomas Howell* 22461 in 1946 (USN, aments to 6.5 cm.); MONO CO., Mt. Dana area, *Milo S. Baker* 173a in 1925 (CRB); *Ball, Bracelin, & Kautz* 527, 531 (2 sheets) in 1931 (CRB, USN); *C. W. Sharsmith* 107 in 1933 (CRB), 2098, 2124 (2 sheets) in 1935 (CRB); east of Mt. Conness, elev. 10,000 ft., *John Coulter* 8 in 1932 (USN); MADERA CO., Yosemite Natl. Park, Mt. Florence, *W. C. Blasdale & H. M. Evans* on July 26-29, 1931 (CRB); MARIPOSA CO., Yosemite Natl. Park, Vogelsang Pass, W. C. Blasdale on July 31, 1931 (CRB, 3 sheets); TUOLUMNE CO., Yosemite Natl. Park, Mt. Dana, *Ball, Bracelin, & Kautz* 522 in 1931 (CRB, 3 sheets); Gaylor Lakes, *Ball et al.* 537, 539 in 1931 (CRB); *C. W. Sharsmith* 2262 in 1936 (CRB); Mt. Lyell, *Helen Sharsmith* (both sexes) in 1932 (CRB).

CALIFORNIA (northern, elev. 7700-9000 ft.): NEVADA CO., Castle Peak, *J. G. Lemmon* (as *S. petraea*) in 1875 (USN, annot. Schn.); Castle Peak Ridge. *L. S. Smith* 2508 (F. S. 59703) in 1928 (CRB); SHASTA CO., Lassen Volcano Natl. Park, Emerald Lake, *Ball, Bracelin, & Smith* 688 in 1932 (CRB); *E. B. Copeland* (both sexes) on Aug. 16, 1931 (CRB, USN); Peaks of Sierra Nevada, *J. G. Lemmon* (as *S. arctica* var. *petraea*) in Aug., 1874 (USN).

CALIFORNIA (southern ?, elev. 10,000-11,100 ft.): counties not known, Mt. Brewer, *W. H. Brewer* 1734 in 1863 (USN, annot. Schn.); 2804 in 1864 (USN, annot. Schn.); At head of San Joaquin Valley, *W. H. Brewer* 2835 in 1864 (USN, annot. Schn.); Donohue Pass, *H. M. Evans* (as *S. arctica*), no date (CRB); Mt. Goddard, *H. M. Hall & H. P. Chandler* 685 (as *S. arctica petraea*) in 1900 (USN, annot. Schn.); Sierra Nevada near Summit Valley, *C. G. Pringle* (as *S. arctica* var. *petraea*) on Sept. 27, 1882 (USN, 2 sheets, annot. Schn.).

Generic Name for Imperfect Yeasts, Cryptococcus or Torulopsis?

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Lodder (1934) used the generic name *Torulopsis* in her important monograph on anascosporogenous yeasts, thereby rescuing the name from virtual oblivion. She used this name instead of *Torula*, currently used by writers on yeasts. Other mycologists were and are using *Torula* in its earlier sense to refer to certain dematiaceous molds. Berlese (1894) had created the generic name *Torulopsis* to correct this error. Unfortunately, the paper in which *Torulopsis* was first described is very rare. The author has not been able to locate a copy and of all modern writers who have cited the paper, only Ciferri (1925) and Ciferri and Redaelli (1929) had actually seen the paper, although Lodder (1938) had access to a typewritten copy. Judging from these, *Torulopsis* was described as a genus consisting of fermenting, anascosporogenous, non-mycelial, non-apiculate yeasts. The name *Torulopsis* was practically unused for twelve years until Saccardo (1906) revived it and again included fermenting abilities in its properties: "Fermentationem alcoholicum excitat." Lost among the Saccardo genera, it was again neglected for another nineteen years until its second revival when Ciferri (1925) emended the genus. He omitted any reference to fermentation in his emendation. Four years later, Ciferri and Redaelli (1929) added among other but minor characteristics, these words: "little or no fermentative power." Since these workers (1925) were principally interested in non-fermenting yeasts with reddish carotinoid pigments, these organisms were given emphasis. Furthermore, they attempted to follow Ciferri's division into *Torulopsis* and *Eutorulopsis* on a basis difficult or impossible to maintain. Again the generic name *Torulopsis*, was generally ignored until the third revival of it by Lodder (1934) nine years later.

Dodge (1935) described the genus by repeating Ciferri and Redaelli's description which attributed little or no fermentation to the genus. Moreover, he emended it by adding the possession of reddish carotinoid pigments. Since none of the known carotinoid containing species (Lodder 1934) is a fermenter, the whole cycle has been completed. Originally a genus, all species of which ferment and with only one red-colored species, *Torulopsis* now appears as a non-fermenting genus including only species with reddish carotinoid pigments. Dodge did list one species which fermented, but inasmuch as this species was stated to ferment fructose and not glucose, an unbelievable combination according to students of yeast metabolism, it is probable that Dodge was mistaken in accepting the original description of this species. Moreover, it is very unlikely that this or any other carotinoid-containing species really ferments sugars. Dodge thus made *Torulopsis* Berlese emend. Dodge 1935, synonymous with

Rhodotorula Harrison emend. Lodder 1934. Lodder (1934) had already emended *Torulopsis* to exclude species with carotinoid pigments as seems proper to us from phylogenetic considerations. She included both fermenting and non-fermenting species. In this sense, forty years after the generic name *Torulopsis* was introduced, it came into common usage under Lodder's emendation.

Thus *Torulopsis* has had at least three different interpretations, and in addition there are cases of combinations with entirely extraneous species. However, this should cause little difficulty since the type species may fix the norm of the genus. The question of type species is slightly confused. The first species listed by Berlese was *Torulopsis rosea*, a fermenting organism, "vigorosa fermentazione alcoolica," with oval cells which become round and with large central "oil drops" when transferred to plaster of Paris blocks, after which growth takes on a reddish color. Its habitat was given as grapes but it was also found on other fruits, leaves and dry wood. Lodder (1934, 1938) was of the opinion that *Torulopsis rosea* was probably identical with the earlier *Saccharomyces pulcherrimus* Lindner, and so she used *Torulopsis pulcherrima* (Lindn.) Sacc. as the name of the type species. Saccado (1906) had placed *Torulopsis rosea*, the first on his list, and Dodge (1935) also accepted this species as the type, although it hardly fits into his description of *Torulopsis*. As a fermenter, it is most unlikely that the pigment is a carotinoid. Ciferri and Redaelli (1929) confused the issue by giving up *Torulopsis rosea* as the type species and substituting another, *Torulopsis gelatinosa* (Will) Cif. & Red. This species is non-fermenting and has carotinoid red pigmentation, i.e., it is a *Rhodotorula*. With this typing, unfortunately the type species cannot fit into the original concept of *Torulopsis*, all species of which ferment. Berlese was definite on this point: "Parecchi specie si cognosco [i.e. *Torulopsis*, the last word of the previous sentence] ed hanno tutte la proprietà di provocare la fermentazione alcoolica."

Thus it seems that *Torulopsis* can be maintained as Lodder describes it as long as it contains the type species *Torulopsis rosea*, or *Torulopsis pulcherrima* if *T. rosea* and *Saccharomyces pulcherrima* are identical, and unless there is an earlier and valid generic name. There is an earlier generic name, currently having consideable usage, and the status of that genus should be duly considered.

Cryptococcus was first described by Kützing. The writer was unable to consult the original paper, but another paper (Kützing 1833) of the same author was published the same year in which the diagnosis was repeated. This description, as was usual at that early date, consisted of only a couple of lines and could fit a number of genera of fungi or algae at some stage of their life cycle, "Globuli mucosi hyaline non colorate microscopici in stratum indeterminatum mucosum secedens sine ordine aggregati." Very many of our currently used generic names described at this early date have equally as indefinite original diagnoses. The habitat was given as a dirty window pane. Throughout several years (see Dodge 1935) several species were described by Kützing. The first

species which is certainly a yeast and no other kind of organism was named in 1843 when the undoubted yeasts *Mycoderma cerevisiae* Desm. and *Torula cerevisiae* Turpin were stated to be synonyms of Kützing's *Cryptococcus fermentans* discussed but not officially named as early as 1837 (Dodge 1935).

It is clear to all who have examined the publications of Kützing that he was very much influenced by the current ideas of pleomorphism and considered his organisms to be algae. This, as is well recognized by taxonomists, is without significance as to validity. For instance, *Coccidioides* and *Histoplasma* are perfectly valid generic names of fungi although they were described as protozoa. Robin (Dodge 1935) in the 1853 publication of his important thesis, used *Cryptococcus* for yeasts and described new species supposed to be pathogenic. Fresenius (Lodder 1934, Dodge 1935) in 1852 described *Cryptococcus glutinis*, a yeast, and the prestige of so eminent a mycologist might well have fixed the generic name *Cryptococcus* to yeasts but for the subsequent lack of interest in them. For instance, De-Toni (1889) in volume 8 of Saccardo lists perfect and imperfect yeasts in the same genus, *Saccharomyces!* When the interest in yeasts was revived by a bacteriologist and a specialist in yeasts, Pasteur and Hansen, they unfortunately adopted the generic name *Torula* in the later sense of Turpin and not in the earlier sense of Persoon, as mycologists were and are presently using it. However, the eminence of Pasteur and Hansen in the field of zymology was such that practically all writers continued to use *Torula*.

Vuillemin (1901) revived *Cryptococcus* as a generic name for anascosporogenous parasitic yeasts. The first species mentioned was the Busse-Buschke yeast which he called *Cryptococcus hominis*. The crediting of this species to Costantin (1901) is incorrect. He used *Saccharomyces* as the generic name in the paper cited. The date of *Cryptococcus hominis* Vuill. is not 1898 or 1902 as sometimes given, but 1901. This has been verified by reference to the 1898 and 1901 papers. Vuillemin's description was scanty but the typical figures of the organisms in tissues leaves no doubt that this is the pathogenic species which Benham (1934, 1935a, b) and Lodder (1934) showed to be identical with the later *Torula histolytica* Stodder & Cutler, and the earlier *Saccharomyces neoformans* Sanfelice. Accepting Vuillemin's usage, which is clear enough, and his description, which, except for the figures, is meager, as an emendation, the type species of the emended genus can be accepted as *Cryptococcus neoformans* (Sanf.) Vuill. This usage of *Cryptococcus* for parasitic yeasts was followed for many years. Guilliermond (1912, 1920) in his famous monographs furthered this usage, but since only medical writers dealt with these yeasts, they were usually the only persons who actually published on *Cryptococcus*. Later Guilliermond (1928) reduced *Cryptococcus* to synonymy with *Torula*, but since the book in which this change was made did not have as wide distribution as did his earlier monographs, *Cryptococcus* continued to be used by nearly all who dealt with parasitic species.

Apparently, Anderson (1917) was the first writer to use *Cryptococcus* to include fermenting as well as non-fermenting species. Ota (1925) included a fermenting species of *Cryptococcus* in the second of his three systems. Both

Anderson (1917) and Benham (1935) with clear logic maintained the validity of *Cryptococcus* and since they saw no reason to split the genus on habitat, and apparently did not consider the possibility of splitting it on other characters, they used *Cryptococcus* for both fermenting and non-fermenting, and parasitic and non-parasitic species, describing new fermenting species and making new combinations.

Thus there is a currently used generic name that has priority over *Torulopsis*, but its validity is not clear. Lodder (1938) considers *Cryptococcus* both a *nomen dubium* and a *nomen confusum*. It can be so considered, but so could a large number of currently used generic names since they are described in equally as indefinite a manner and some are based on obviously mixed elements. However, for the sake of eliminating *Cryptococcus* it may be well to utilize this line of reasoning. In opposition to Lodder's arguments (1934, 1938), which are indeed clear, logical, and generally pertinent, Benham (1935a, b) and Dodge (1935) maintain as clearly and logically the validity of *Cryptococcus*. Today practically all medical writers in North America, and some of them in Europe and Latin America use *Cryptococcus* and most non-medical writers use *Torulopsis* although many of these unfortunately still use the admittedly invalid name *Torula*. There is undoubtedly a larger literature on *Cryptococcus* than on *Torulopsis*. The present day literature on *Cryptococcus* is very large but probably not so large as that on *Torulopsis*, and the latest and outstanding monograph (Lodder 1934) on the organisms in question uses *Torulopsis*. It would be well if all could agree to use the same generic name. If a clear case for one or the other of these two generic names cannot be reached, possibly a basis for action by the only body competent to set aside the rules may be found, namely an International Botanical Congress, which may authorize a *nomen conservandum*.

Before discussing the availability of *Cryptococcus*, we should determine whether or not *Torulopsis* is available. As was stated, Lodder (1934) identified the earlier *Saccharomyces pulcherrimus* Lindn. with the first of Berlese's species *Torulopsis rosea*, and thus used *Torulopsis pulcherrima* as the type. Since then, Diddens and Lodder (1942) have removed this species from the genus. The writer (Skinner and Bouthilet 1947) assumed that Ch. III, Sect. 2, Art. 18 of the International Rules ("The name of a group must be changed if the type is removed"), which are "always retroactive" (Ch. I, Art. 2), made it impossible to maintain *Torulopsis* for the remaining species in the genus. In a personal communication Dr. Lodder apparently assumed that the genus could be retyped, but all the taxonomists consulted by the writer have insisted that if *Torulopsis rosea* is the first mentioned species and the only recognizable one, it is the type species and must remain so, although the specific name should be changed to *pulcherrima*. However, even if this interpretation of Ch. III, Sec. 2, Art. 18 is correct, and it certainly seems to be, still *Torulopsis* may be available in case Lodder (1934, 1938) was mistaken in her identification of *T. rosea* with *S. pulcherrimus*. She was conservative in her statements and did not express certainty as to this identity of the species, rather a fairly mild opinion, in which the author believes she was mistaken. The reddish color of

both species together with fermentation is the principal reason for this identification. However, some fermenting sporogenous and asporogenous yeasts develop a pinkish color in aging cultures. *Torulopsis rosea* showed this reddish color only after being grown on a substrate and then transferred to plaster of Paris blocks. On the other hand, all of the dozen or so isolates of *Torulopsis pulcherrima* studied by the writer, very soon became a maroon in color, or the medium was quickly colored unless it was specially prepared to be free of iron. And when the growth was transferred to plaster of Paris blocks, there was no enhancement whatsoever of the color, rather the contrary. Therefore, the writer is of the opinion that *Torulopsis rosea* is not *Saccharomyces pulcherrimus*, at least it is not so with sufficient certainty to consider *Torulopsis pulcherrima* the type species. This leaves *Torulopsis* available. The first recognizable species is *Torulopsis colliculosa* (Hartmann) Sacc. 1906.

Unless it is decided to consider *Cryptococcus* a *nomen confusum* or a *nomen dubium*, this name has priority over *Torulopsis*. The first recognizable species of *Cryptococcus* is *Cryptococcus hominis* Vuill. 1901, i.e. *Cryptococcus neoformans* (Sanfelice) Vuill. Fresenius' 1852 description of *Cryptococcus glutinis* would fit several of the species of *Rhodotorula* (Lodder 1934, Dodge 1935). Thus it would seem that unless *Cryptococcus* is thrown out on the basis of its indefinite early description and proven mixed elements (Lodder 1938) in herbarium material, it has priority. *Cryptococcus* has been used for well over one hundred years, and for yeasts only except for faulty combinations with species of molds and bacteria. It has had a much greater usage in the past and has a very wide current usage. If it is considered that the relatively recent use of *Torulopsis* in the outstanding monograph on the subject (Lodder 1934) makes the use of this name preferable, there are three ways that *Torulopsis* may be justified. First *Cryptococcus* may be considered a *nomen confusum* and a *nomen dubium*. Obviously many workers do not so consider it. Secondly, *Cryptococcus* may be eliminated by having an International Botanical Congress validate *Torulopsis* as a *nomen conservandum*. It is not certain that the near unanimity of consent necessary to accomplish this can be obtained. Thirdly, the genus may be divided.

This latter solution is a practical compromise that might be considered. It is practical because it would cause a very slight change of usage and would not require the creation of a *nomen conservandum*. Non-medical writers generally use *Torulopsis* and deal very little with any but fermenting species. Medical writers commonly use *Cryptococcus* and most of them deal only with non-fermenting species. By accepting *Cryptococcus* as a valid genus, one can segregate the fermenting species in another genus, e.g. *Torulopsis*. *Cryptococcus* would thus contain the smaller number of species, those less widely distributed, those least known and of least importance to all but medical writers. There is only one species of fermenting, non-mycelial yeast known to be pathogenic, *Torulopsis glabrata* (Anderson) Lodder & de Vries (1938) and this is not of great importance. *Torulopsis* would be used exactly in the Berlese and the Saccardo sense which includes fermentation as a generic character, and as it was described up to the emendations of Ciferri, Lodder, and Dodge. In practice,

since most pathogens or supposed pathogens do not ferment, it would nearly follow the Guilliermond (1912, 1920) system so generally followed for many years. This was adopted in a slightly modified form by Ota (1925) and by the famous Latin American team, Almeida et al. (1941), in their practical system. Earlier Almeida (1939) in his textbook had given up parasitic habitat as a character of *Cryptococcus* and had substituted other characteristics. In principle, the suggested system follows the usage of *Cryptococcus* by Dodge. It merely would utilize an acceptable taxonomic criterion, fermentation, for one now rarely held tenable, habitat, used by Guilliermond and others but since most parasitic or supposedly pathogenic species are non-fermenters, it does not materially change usage except in those systems (e.g. Guilliermond) where *Torula* would have to be changed to *Torulopsis*, a change in usage rather generally made already. Such a solution would require no action by an International Botanical Congress.

Dr. Lodder in a recent personal communication has expressed a favorable interest in such a solution of the problem. However, she is inclined to favor a separation of the genera on the basis of encapsulation. Almeida et al. (1941) used this character together with fermentation in their practical system. Actually, the end results would be much the same. The type species, *Cryptococcus neoformans*, an encapsulated non-fermenting yeast, and *Torulopsis rosea*, a fermenting and presumably non-encapsulated species would set the norm. As always, individual writers are free within the rules, to set the limits of genera so long as they keep the type species in the proper genus. In either case no action is needed to make another *nomen conservandum*.

There is more to be said for the proposed solution than practicability, compromise though it be called. It is phylogenetically justified. It is true that imperfect fungi are classified into "form genera" which because of their very nature are based on convenience rather than phylogeny. Still, as far as possible, form genera are classified and reclassified into phylogenetically related units. It is becoming more and more evident that fermenting species of anascosporogenous, non-film forming, non-apiculate yeasts have had their origin in the perfect genus *Saccharomyces*, a genus of the Ascomycetes. All species of *Saccharomyces* are fermenters. Moreover, all of the haploid segregates of *Saccharomyces* and all of the hybrids of this genus ferment at least glucose (Lindegren, personal communication). According to the Kluyver "law" if a yeast ferments any sugar, it ferments also glucose. But the non-fermenting species of this group of anascosporogenous yeasts have no known corresponding perfect genus. We have a hint of a possible source of their origin from some observations of Mackinnon and Artagaveytia-Allende (1941) and Mackinnon (1946) who indicated the probable origin of certain non-fermenting colorless anascosporogenous yeasts from species of *Rhodotorula*, and hence from the Basidiomycetes through *Sporobolomyces* and the Heterobasidiomycetes. At any rate, there is no reason to assume that non-fermenting and fermenting yeasts are related. By separating species of these asporogenous yeasts into two genera, we practically separate the "medical" and the "industrial" asporogenous yeasts as did Guilliermond and his followers, but we base the separation on a

basis more readily justified in a natural system. Lodder (1934) anticipated the above suggestion in making the primary subdivision of species of *Torulopsis* into fermenting and non-fermenting species.

There are two points that the writer wishes to make very clear. First, if *Cryptococcus* is valid for any species, it is the older name, and International Rules are clear that it would have to be used by those writers who do not choose to divide the genus. Second, the writer is not making emendations here. It must be emphasized that any recommendations of individuals, societies or congresses will have to be justified under the International Rules if general acceptance is to be expected. If *nomina conservanda* are to be proposed, they must be finally accepted or rejected by the only body competent, under the rules, to act: namely an International Botanical Congress. It is to be hoped that persons who feel inclined to make emendations, or other drastic changes in the nomenclature of these organisms, will wait for recommendations of various committees now at work on the problem. If proposals for *nomina conservanda* are duly made, most workers will no doubt be guided by such action until these proposals can be accepted or rejected.

The writer does not give serious consideration to any suggestion that the recent rules for bacteriological nomenclature, agreed upon by an International Microbiological Congress, and not the International Rules of Botanical Nomenclature should apply to yeasts. First, yeasts are not bacteria, they are true fungi. Second, in all but minor and non-pertinent points the rules are identical.

The author (Henrici et al. 1947) prepared a key for anascosporogenous yeasts largely derived from Lodder's key to *Torulopsis*. Since it was in a book intended for bacteriologists and since the author then believed that *Cryptococcus* was the valid name, all species were put in that genus with a notation that new combinations would be made elsewhere. Such combinations, actually used, but not validly published, always add confusion in the literature. Therefore, not with the idea of furthering the usage of any generic name, but to minimize confusion in the literature, these fourteen combinations are published here. The other twelve species in the key were originally described in the genus *Cryptococcus*, or combinations in that genus have already been made by others.

Cryptococcus Kefyr (Beij.) n. comb. Syn: *Saccharomyces Kefyr* Beijerinck, 1889. Arch. Néerl. Sci. Ex. Natur. 23: 430. *Torula Kefyr* Beij.; *Torulopsis Kefyr* Lodder.

Cryptococcus colliculosus (Hartmann) n. comb. Syn: *Torula colliculosa* Hartmann; *Torulopsis colliculosa* Saccardo, 1906, Syll. Fung. 18: 495.

Cryptococcus Holmii (Jörgensen) n. comb. Syn: *Torula Holmii* Jörg.; *Torulopsis Holmii* Lodder, 1934, Anask. Hefen 1: 136.

Cryptococcus Molischianus (Zikes) n. comb. Syn: *Torula Molischiana* Zikes: *Torulopsis Molischiana* Lodder, 1934, Anask. Hefen 1: 138.

Cryptococcus dattilus (Kluyver) n. comb. Syn: *Torula dattila* Kluy. *Mycotorula dattila* Harrison; *Torulopsis dattila* Lodder, 1934, Anask. Hefen 1: 139.

Cryptococcus Gropengiersseri (Harrison) n. comb. Syn: *Torula Gropengiersseri* Harrison, 1928, Trans. Roy. Soc. Canada, 3 Ser. 22: 204. *Torulopsis Gropengiersseri* Lodder,

Cryptococcus bacillaris (Kroemer et Krumholz) n. comb. Syn: *Saccharomyces bacillaris* K. et K.; *Torulopsis bacillaris* Lodder, 1934, Anask. Hefen 1: 149.

Cryptococcus stellatus (K. et K.) n. comb. Syn: *Saccharomyces stellatus* K. et K.; *Torulopsis stellata* Lodder, 1934, Anask. Hefen 1: 151.

Cryptococcus Laurentii (Kufferath) n. comb. Syn: *Torula Laurentii* Kuf.; *Torulopsis Laurnetii* Lodder, 1934, Anask. Hefen 1: 160.

Cryptococcus albidus (Saito) n. comb. Syn: *Torula albida* Saito; *Torulopsis albida* Lodder, 1934, Anask. Hefen 1: 163.

Cryptococcus candidus (Saito) n. comb. Syn: *Torula candida* Saito; *Torulopsis candida* Lodder, 1934, Anask. Hefen 1: 164.

Cryptococcus flavescens (Saito) n. comb. Syn: *Torula flavescens* Saito; *Torulopsis flavescens* Lodder, 1934, Anask. Hefen 1: 166.

Cryptococcus luteolus (Saito) n. comb. Syn: *Torula luteola* Saito; *Chromotorula luteola* Harrison; *Torulopsis luteola* Lodder, 1934, Anask. Hefen 1: 169.

Cryptococcus lipoferus (den Dooren de Jong) n. comb. Syn: *Torula lipofera* d. Door. d. Jong; *Torulopsis lipofera* Lodder, 1934, Anask. Hefen 1: 173.

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Book Reviews

ECUADOR AND THE GALAPAGOS ISLANDS. By Victor Wolfgang Von Hagen. University of Oklahoma Press, Norman. 1949. Large 12mo., cloth, 290 pp., illus., maps, bibliography. $3.75.

The very name, South America, has long possessed a magic appeal to many scientists, and the number is almost staggering of those people, over the years, who have explored or who have written about the rich and varied flora and fauna of that great country. This, of course, has not been confined to any one or two or even a few phases of interest, for very nearly the whole field of natural history has been included in such exploratorial activity.

It is therefore with quickened interest that the scientific fraternity welcomes this latest very interesting, and well written contribution and is glad to give it place on the shelves alongside other previously issued volumes on the same subject. Needless to add that it gives much down to date information concerning areas of that continent that have been objects of study and observation from the period of Darwin to the present. The republic of Ecuador has been termed a perfect springboard to South America, and is probably most typically representative of the Andean republics. In a comparatively small area, desert, jungle and snow-covered volcanoes follow each other in immediate succession. Its world is violent: Andean moorlands alternate with fertile, temperate-climate valleys, and these in turn are broken up by earth fissures that split its troubled typography into isolated fragments. Yet, it was in that country that, among other things, the first potato was developed, and rubber and platinum were there discovered and introduced into Europe. It has a monopoly of the world's balsa, almost all of the so-called Panama hats are made there, and much of the world's chocolate comes from this republic on the equator.

However, Ecuador has contributed more than these products of economic value, — important though they be. It also has had a distinguished past: From out of it there marches enough heroes, saints and picaros to fill a new Iliad. The last of the reigning Incas, Atahualpa, was born and fought there. Some of the greatest of the Spanish conquistadores rode over its variegated land—among them such as the brothers Pizarro, Benalcázar, Orellana, and De Soto; many buccaneers cut their teeth on Ecuador's coast, Francis Drake, Bart Sharp, Lionel Wafer, Ambrose Cowly and others. However, if pirates were attracted by its treasures, so were latter-day explorers by its natural history. We find that the Amazon River was first ascended and descended with Quito as goal and as starting point, and that the first map of that fabled stream was made in Quito by a Jesuit, Samuel Fritz, a German priest, who had adopted Quito as his own in the seventeenth century. When the French Academy wanted to prove Isaac Newton's theory of the shape of the earth, it was to Quito, in 1735, that it sent its first scientific expedition to the New World. Among them was Antonio de Ulloa, the first and only Spanish governor-to-be of Louisiana, then a mere eighteen-year-old lieutenant of the King's Armada. These explorers in turn were followed by the noted Alessandro Malaspina, who sailed his exploring ships to Ecuador, and he was soon followed by the young Baron Alexander von Humboldt—the most renowned of all—with his amiable companion and medico-botanist, Aimé Bonpland; in Ecuador scientific history was made.

Then too, it was on the soil of Ecuador—those cinder heaps called the Galapagos Islands, that there came the naturalist of H. M. S. *Beagle*, to conceive the theory of evolution. After Darwin came Herman Melville who appeared there briefly, as did Lord Byron, the son of foul-weather Jack; and Commodore David Porter, commanding the U. S. S. *Essex*, too was there in 1814, making trouble for British shipping; and, with him, midshipman David Farragut. Among still others who visited that area and recorded their experiences were Joseph Boussingault, whom Bolívar brought over from France to operate Colombian mines, Frederick E. Church, the last of the Hudson River School of painters, whose colossal canvas "The Heart of the Andes," publicized Ecuador. Yet others were Richard Spruce and William Jameson, indefatigable botanists; James Orton and a group

of American scientists to make descent of the Amazon, Wolf, the Jesuit geographer; Kolberg, mathematician, and numerous others.

So rich, so utterly unique, so living was the reputation of Ecuador's singular biota, that a veritable regiment of scientist-explorers throughout the century came to its geographical fairy land and later produced their published impressions. However, despite its long and impressive bibliography, and the contemporary work being done there, which is also discussed at length by Dr. Hagen, yet Ecuador still remains one of the least known of the Hispanic-American republics; thus the justification for still another book about Ecuador, and his colleagues in science will be grateful to the distinguished author of this latest work for the very able presentation that has been made of the subject.—J. S. WADE, U. S. Department of Agriculture, Washington, D. C.

CLIMATIC ACCIDENTS IN LANDSCAPE MAKING. By C. A. Cotton. (First published, November, 1942, by Whitcombe and Tombs, Limited, Christ Church, New Zealand) John Wiley and Sons, Inc., N. Y. 1948. xx+343 pp.; 149 text figures, frontispiece in kodachrome color; 48 plates, 2 photographs to a plate. $7.00.

This book is one of a trilogy written by Professor Cotton; the other two are *Landscape*, first published in 1941 (reprinted 1948) and *Volcanoes as Landscape Forms* in 1944. Collectively the three constitute a comprehensive survey of the geomorphology of the lands. It is fitting to pay tribute to the unflagging zeal of the author and the enterprise of publishers in making these three volumes available to students of geomorphology. Professor Cotton originally planned to compress his account into two books; when this proved not feasible he unwearyingly proceeded to do the third.

The author is a steadfast adherent of the explanatory approach to the description of landforms formulated and established by W. M. Davis. The title, "Climatic Accidents in Landscape Making," serves to emphasize Professor Cotton's conviction that Davis's distinction between "normal" (humid), "arid," and "glacial" geographic (geomorphic) cycles is a warranted one, in view of faultfinding to the effect that a humid cycle is no more normal in geomorphic development than are arid and glacial cycles. As it becomes increasingly evident from geologic evidence that through much of earth history the lands were provided with a warm humid climate such carping loses point. In any event, Professor Cotton's book demonstrates that a well-rounded body of geomorphic phenomena and features may be convincingly presented when set off as the outcome of climatic accidents.

Of the 343 pages of text, 121 are devoted to the arid cycle, 222 to glacial developments. The nearly double space given to the glacial items is indicative both of the comparative amount of information available and the measure of interest in the two topics. Perhaps it is also an indication of the special interests of the author who has been a noteworthy contributor to the study of glacierization and glaciation in New Zealand, his home.

The books, *Climatic Accidents* and *Volcanoes as Landscape Forms* differ slightly from *Landscape* in that they are systematically documented, page by page, whereas the citations in *Landscape* are less numerous and are referred to lists at the chapter ends. The author assumes that a reader comparatively uninformed in geomorphology will find it easy to follow his discussions and emerge from their perusal with a greatly enlarged horizon in this field of study. This reviewer is not so confident on this point. In refreshing fashion Professor Cotton plunges directly into his subject. No tedious preliminaries. However, his representations are definitely clipped. It is, in fact, remarkable how, through the years, the author has kept track of all significant papers and extracted from each the kernel of the contribution and fitted it into his exposition. He is also to be commended for the catholicity of his survey. Items which have not "caught on" receive appropriate attention as well as those deriving from the acclaimed pundits. Incidentally, he is notably modest in making reference to his own contributions. Accordingly, the near tyro who accepts Professor Cotton as his guide, and turns to the literature he cites, will, if he pursues his reading faithfully, be truly and fully informed on the status of every topic in the subject up to the date of publication. For the well-tutored geomorphologist Professor Cotton's account provides a survey which will bring to attention ideas and approaches he may have overlooked or forgotten.

On the other hand, it is disappointing not to learn which interpretation Professor Cotton supports on controversial topics such as, e.g., pedimentation and the nature of glacier flow. In many places he is exasperatingly elusive in regard to conclusions. In view of his careful studies and notable competence Professor Cotton is eminently qualified to pass judgment in regard to the relative adequacy of various contentions. He inveighs, mildly, against the coining of new terms; says geomorphologists recently have "cast hesitation to the winds" in this matter. In the large he is correct in making this reproach but he perhaps overlooks that the master, W. M. Davis, thought one of his major contributions was the provision of a terminology, and possibly does not realize how much he himself relies on such short hand, to be sure "in quotes," in making his characterizations. Possibly the proper answer in this predicament is to suggest the free adoption of apt foreign terms for which no exact English equivalent exists, e.g. knick, névé, esker, barchan, bajada, and accept other coinages only when they serve distinctively to designate a complex concept, e.g. pediment, periglacial, lineament, ventifact.

It must suffice here to follow Professor Cotton through only one topic as an illustration of his presentation. Selection of the first chapter, "Aeolian Erosion," for this purpose may be regarded as indicative of no prejudice. His phrases are necessarily severely compressed but it is thought the picture is not unfairly lighted.

'Often said or implied major desert landforms due to wind erosion.' 'Modernly doubted.' 'However, escarpments and buttes with no talus at base attributed to wind erosion.' 'But sheetfloods may have carried away the rubble.' 'Deflation, i.e. "exportation" only means for continuous and differential lowering of desert land surface.' 'Facets on pebbles positive evidence of efficacy of wind abrasion.' 'Even where sandblast most effective it rarely appears that aeolian abrasion is chiefly responsible for the development or steepening of cliffs.' 'Soft selenite crystals, demontsrated by laboratory experiments to be susceptible to wind abrasion, occur unaffected by such scour in deserts.' 'Rapid abrasion only in soft materials, creation of yardangs.' 'Pedestals are due to weathering.' 'Honeycomb lattice cannot be ascribed to wind abrasion.' "Lag gravels," "boulder pavement," 'very resistant to further deflation.' Some 26 references are cited to validate this account.

One may conclude that Professor Cotton considers the weight of evidence to be against any heightening of desert relief by abrasion, but that the lowering of desert surfaces, and hollowing out of certain parts of them, are achieved by the exportation phase of deflation. But he does not commit himself to such a summary.

In conclusion it may be said that the bookmaking is excellent; the print clear; the text figures (block diagram, Davis type) regularly convincing representations; the half tone reproductions of photographs clean, on coated paper, all at the end of the book. This last is inconvenient but endurable in preference to the muddy effects so commonly provided.—O. D. VON ENGELN, Cornell University, Ithaca, N. Y.

ROCKY MOUNTAIN TREES. By R. J. Preston, Jr. Iowa State College Press, Ames. 1947. Second edition, 285 pages + lxxx, 125 plates. $2.50.

Too infrequently, manuals intended for the description and identification of regional floras, embody sufficient critical information presented in concise, clear and not too technical language, to permit extensive use by the professional botanist and amateur as well. Too frequently floras are so simplified and stereotyped that they serve as guides only to the extent that species can be identified solely by comparison with the illustrations provided. Thus critical identifications are questionable and very often impossible. Such is not the case of Preston's *Rocky Mountain Trees* which covers an arboreal flora within an area bounded by Idaho and Montana on the north, and Arizona and New Mexico on the south, including a section of western Texas.

Although there are other excellent manuals (Rydberg, Coulter-Nelson, etc.) on the flora of the Rocky Mountains, in the writer's opinion *Rocky Mountain Trees*, except for state and local floras, is the first that confines itself exclusively to the identification and knowledge of gymnosperms and angiospermous trees of this entire region. The concise

description of 252 native or naturalized species follows a general pattern on habit, leaves, flowers, fruit, twigs, bark, wood, silvical and other general characteristics. All can easily be identified through the use of the provided generic and specific keys together with the profuse large-size, clear line illustrations and the accompanying distribution and zone maps. For the area covered, there is a check list of the trees found within each state and the nomenclature used is now in conformity with the International Rules.

It is the reviewer's modest opinion that *Rocky Mountain Trees* will prove very useful for the rapid identification of trees not only by the botanist and forester but also by the woodsman who may be only vaguely familiar with the botanical terminology. The latter and the layman may quickly learn to use the manual by reference to the glossary and the excellent keys. The volume will no doubt enhance the appreciation of trees in a region so richly endowed as is the Rocky Mountains.—A. L. DELISLE, University of Notre Dame, Notre Dame, Ind.

AN INTRODUCTION TO PLANT ANATOMY. By Arthur J. Eames and Laurence H. MacDaniels. McGraw-Hill Book Company, Inc., New York. 1947. Second edition, xvii+427 pages, 186 figs. $4.50.

Teachers of plant anatomy have long looked forward to the revision of this standard text which first appeared in 1925. Considerable advances have been made in this subject during the last quarter of a century, and this progress is reflected in this edition, for more space is devoted to the structure, origin, and chemical composition of cell walls, including the recent work of I. W. Bailey; to meristems and the development of the primary body, incorporating the significant researches of A. S. Foster and Katherine Esau; to phloem structure and development, including the results of the investigations of Dr. Esau and V. I. Cheadle; to abscission of leaves and other organs; and to the ontogeny of leaves. There is a thorough revision and expansion of the chapter on floral anatomy which will be a great boon to many instructors of plant anatomy who may not be as familiar with this aspect of plant anatomy as is Professor Eames, from whose laboratory dozens of papers on this subject have appeared during the last three decades.

The terminology used in the book has been brought into conformity with that adopted by the International Association of Wood Anatomists and published in the form of a Glossary in the journal *Tropical Woods* in 1933. The authors have taken special pains to point out the frequent misapplication of the term pericyclic fibers to many undoubted phloem fibers. They make a distinction between sieve cells and sieve-tube elements. Unfortunately, they have omitted the chapter on the history of plant anatomy which many users of the former edition considered one of the best sections of the previous edition. It is hoped that this excellent chapter will be restored in the next revision of the book, and it is further suggested that the diagram showing development of the axis (Fig. 58) be redrawn so as to include lateral appendages. After all, these appendages play a profound role in determining the architecture of the apex and it is therefore unrealistic not to show their presence.

This book, like most of the books in the Botanical Series of the McGraw-Hill Book Company, is printed on good paper, is well edited, and has excellent illustrations. Many plant anatomists will continue to regard Eames and MacDaniels as the most comprehensive and best illustrated plant anatomy text in the English language.—OSWALD TIPPO, Department of Botany, University of Illinois, Urbana.

PRACTICAL PLANT ANATOMY. By Adriance S. Foster. D. Van Nostrand Company, Inc., New York. 1949. Second edition, xi+228 pages, no figs. $3.00.

In the Preface, the author restates the objectives of his book, first enunciated in the first edition of 1942: "to provide for the student a means of articulating the practical study of laboratory material with the best of modern theory and interpretation." Thus, this book is intended primarily as a laboratory manual and as a guide to the literature of the subject, especially the most recent papers and, moreover, as a critique of this literature.

Each of the fifteen chapters or exercises begins with an introductory section, followed by critical comments on recent research. Towards the end of each exercise, practical laboratory work is suggested and outlined. Each exercise is concluded with an excellent bibliography, listing references to selected classical works as well as to the important recent papers. The references and the comments on them are among the most valuable features of the book.

As in the first edition, the book contains excellent sections on meristems, the structure and development of phloem, and the differentiation of leaves. In addition, there is a valuable critique of the various systems of tissue classification and in the Appendix, Professor Foster has summarized some of the more important anatomical laboratory methods, including the clearing technic. The present edition gives greatly expanded treatment to meristems, sclerenchyma—especially sclereids, structure and ontogeny of primary vascular tissues, development of organs, and there is a new exercise on the structure and ontogeny of laticiferous tubes. It has also changed physically from a spirally-bound manual to a handsome, well-printed, cloth-bound book.

Teachers of plant anatomy who use but one textbook for assigned readings will continue to shy away from this book for it has no illustrations and some instructors feel that it is not comprehensive enough since it gives only cursory treatment to such subjects as the periderm, abscission, and other topics. On the other hand, other teachers of plant anatomy will be attracted by the strong features of this book which include its modernity, its critical approach, and its emphasis on thorough laboratory study. In addition, the author writes with a style which is not only clear and scholarly but which has a grace not often encountered in textbooks. No instructor of plant anatomy, or student of the subject will want to be without this very excellent volume.—OSWALD TIPPO, Department of Botany, University of Illinois, Urbana.

INSECT MICROBIOLOGY. By Edward A. Steinhaus. Comstock Publishing Company, Inc., Ithaca, New York. 1947. Second printing. 763 pp., 256 text figs. $7.75.

This book is an account of the microbes associated with insects and ticks, with special reference to the biologic relationships involved, and is an attempt to bridge the fields in which bacteriology and entomology overlap.

The introduction gives an interesting account of the general problem of biologic relationships and a few highlights of the economic aspects. Also included are a few brief historical remarks. Throughout the book there is additional material of a historical nature in connection with specific groups or organisms, material which adds greatly to the interest of the book.

Chapters 2 and 3 deal with bacteria and insects, Chapter 2 presenting an interesting account of the general relationships between the two, Chapter 3 treating the specific bacteria associated with insects and ticks. These range from bacteria which are definitely pathogens of the insects themselves, to human disease organisms which insects have been found to carry, and to obscure bacteria which have been found in insects but whose role and importance are unknown. The next chapter, 4, deals with intracellular "bacteriumlike and rickettsialike symbiotes," a group of minute organisms which are usually unknown to the entomologist. Of exceptional interest to insect morphologists is the information given in this chapter on the mycetome, a curious symbiont-harboring body of various shapes. Chapter 5 deals with the Rickettsiae, and is an exhaustive account of information on this subject. Chapters 6 and 7 deal with yeasts and fungi, respectively, found in insects. Chapter 8 deals with viruses, in connection with which is a short but very interesting note on the occurrence of bacteriophage in insects. Chapters 9 and 10 deal with spirochetes and other protozoa in insects. A short Chapter, 11, deals with protozoa found in termites.

Chapter 12 deals with immunity in insects and contains an account of cellular and humoral immunity as observed by various investigators.

The last chapter discusses methods and procedures which should be followed by the investigator who wishes to do research in this field, including various techniques for collecting, handling, dissecting, and treating insects, and the special technique which must be followed to obtain material of different parasitic groups of microorganisms.

The 88-page list of references is a most commendable compilation. Most of the papers contained in it are abstracted somewhere in the book itself, which aids greatly in locating desired material.

Entomologists in general will find this book highly stimulating. Dr. Steinhaus has presented abstracts of most of the pertinent literature exactly the way it was reported without attempting to draw wide generalizations. This emphasizes with great clarity the rather insecure experimental data upon which rest some of our glib statements. I doubt if anyone can read the book without realizing the tremendous need for additional work in this field and the promise of a wealth of fascinating problems arising from it.

The entomologist who wishes to really put the book to use will need first to become familiar with the general classification of microorganisms and the techniques of bacteriology, because the book presupposes that the reader is familiar with both. From the standpoint of the entomologist, the inclusion in the book of at least the outline of classification in some of the groups would have been very helpful.

There are certain to be many criticisms leveled at this volume because it covers a tremendous field, and, due to limitations of space, undoubtedly the author has had to make many a choice of material, frequently not making the same choice as would one of the readers. I believe, however, that the author should be congratulated on bringing together such a fine compilation of literature which has heretofore been widely scattered on a subject of such importance. I sincerely hope that the author and the critics will cooperate in making future editions of the book as useful when they are published as this volume is now.—HERBERT H. ROSS, Illinois Natural History Survey, Urbana.

OCEANIC BIRDS OF SOUTH AMERICA. By Robert Cushman Murphy. The Macmillan Company and The American Museum of Natural History, New York. 1948. Square 8vo: Vol. I, pp. i-xxii, 1-640, col. pls. 6, other pls. 1-38, text figs. 1-61; Vol. II, pp. i-viii, 641-1245, col. pls. 10, other pls. 39-72, text figs. 62-80; October, 1948. $17.50.

Few ornithological publications cover the subjects of which they treat so adequately as does the present work. Although the 1936 original, of which this is a reprint, is well known to ornithologists, further attention should now be drawn to it as a thesaurus of information concerning the all too little known birds that are included in its category.

A most important feature is the thorough discussion of the physical environment and faunal influences, which occupies over 300 pages of the first volume. Included there are descriptions of all the land areas involved, together with an analysis of the ocean currents and the zones of surface water, both of which are of particular interest in their relation to the distribution of life in this whole region.

In the main portion of the book there are separate accounts of some 200 species, all sea birds except a relatively few littoral forms. The treatment of each of these is both systematic and biological, and brings together a great amount of valuable information. The accounts of the penguins are particularly satisfactory, since the information regarding these Antarctic birds is widely scattered in the literature and much of it difficult to find. A bibliography and a good index complete the work.

The chief differences between the two editions are that in the present the table of contents is divided between the two volumes instead of being all in the first; and the full page plates are bound together at the end of their respective volumes instead of scattered through the text. Pagination of the main text is identical in both editions.

Anyone seriously interested in water birds should get this book and read it carefully.—HARRY C. OBERHOLSER, 2933 Berkshire Road, Cleveland Heights, Cleveland 18, Ohio.